FLOW GMBH
vision

# Flow Meter | **FC100-CA**
# USER MANUAL

M_FC100-CA_1209_e

**Important:**
Please follow these instructions carefully. Failure to comply, or misuse of this equipment, could result in serious damage both to the equipment itself and to the installation. FlowVision is unable to accept responsibility for customer or third party liability, warranty claims or damage caused by incorrect installation or improper handling resulting form non-observance of these instructions.

Equipment installation, connection and adjustment by qualified personnel only!

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# 1 Description

Flow Meter FC100-CA is suitable for compressed-air and other gas flow measurements under various pressure conditions. It operates on the calorimetric principle and is to be used together with monitoring heads CSx-...

These quantities are made available to the user as analogue electrical signals, physically isolated, as **current** or **voltage output** and may be monitored by means of a **limit monitor**.

As **relay outputs** or **transistor outputs** the digital signals enable the user to integrate the FC100-CA into a control and monitoring system.

The transistor outputs enable the user to additionally process **fault**, **status** and **volume pulse indications** in the control system.

A RS232 interface enables communication with FC100-CA.

## 1.1 Measuring procedure

### 1.1.1 Calorimetric measuring procedure

The calorimetric measuring procedure is based on the physics of heat dissipation, i.e. a body with a temperature higher than its surroundings supplies a medium flowing past that body with energy in the form of heat. The amount energy supplied is a function of temperature difference $\Delta\vartheta$ and mass flow.

Flow Meter FC100-CA operates on the CTD (Constant-Temperature-Difference) method:

The temperature difference $\Delta\vartheta$ between the two sensors is kept constant and the mass flow is determined by measuring the calorific power.

Fig. 1 is a schematic diagram of a CTD method based sensor. Two temperature-sensitive resistors (sensor elements RS and RM) are immersed in the medium. Sensor RM assumes the temperature of the medium $\vartheta_M$ whilst heater resistor RH heats element RS to temperature $\vartheta_S$. As a function of the medium, the temperature differential $\Delta\vartheta = \vartheta_S - \vartheta_M$ is preselected as a reference variable by the CTD control and is kept constant. The required calorific power is a function of mass flow so that the control variable **y** of the control can be used for evaluation.

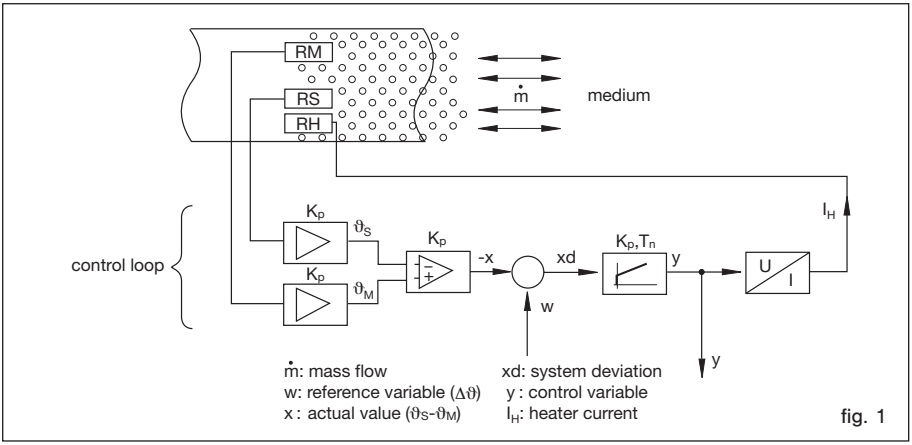


fig. 1

Major benefits of this method are:

- Fast response, particularly in the event of a sudden complete flow stoppage.
- Medium temperature measurement, providing optimal temperature compensation.
- Increased safety because the sensor cannot be overheated during flow standstill.

The flow velocity is determined by mass flow.

### 1.1.2 Physical principles of gas measurement

With the exception of Coriolis meters and calorimetric flow meters, flow meters used for gas measurement are pure volume flow meters that require density $\rho$ to determine mass flow Q from the measured volume flow V:

$$Q = V \times \rho$$

Coriolis meters are used for higher mass flow quantities and higher densities only, where density is directly proportional to pressure and inversely proportional to temperature (related to absolute Kelvin scale).

The quantity required in general practice is mass flow as it indicates the exact gas quantity, whereas volume flow only defines the volume the gas has adopted during the measurement procedure.

### 1.1.3 Standard and operating volume flow

**Standard volume flow**
The calorimetric measuring procedure measures the existing standard volume flow or mass flow without requiring additional pressure and/or temperature measurements. Like velocity changes, pressure fluctuations cause fluctuations in standard volume flow which are indicated as such. The standard volume flow indicated relates to 1013 mbar/14.69 psi and a temperature of 0 °C/32 °F.

**Operating volume flow**
The standard volume flow value is converted into operating volume flow by means of the “ideal gas law”:

$$\frac{P \times V}{T} = \text{constant}$$

with P being pressure, V the volume and T the temperature (related to the absolute Kelvin scale). The pressure to be set on the electronic control unit FC100-CA and the current temperature measured are taken into account and used as a basis. Calculating operating volume flow is only reasonable when pressure is known and constant.

The assigned velocity rates (averaged on the pipe cross section) are converted from standard conditions to operating conditions the same way as volume flow.

### 1.1.4 Measurements in compressed-air systems

The easy-to-fit modular insertion system allows the FC100-CA with insertion head CSP-... to be inserted in 6 different sensor adapters for diameters 1/2“, 3/4“, 1“, 1 1/4“, 1 1/2“ and 2“. This enables to systematically monitor the entire compressed-air system for leakages by providing the appropriate number of sensor adapters and only a few measuring systems. After elimination of the leakages the measuring system can be used for consumption measurements on other measuring locations, e.g. before main loads or in larger pipes of the compressed-air system. The measuring range covering approx. 0 ... 50 $Nm^3/h$ to approx. 0 ... 480 $Nm^3/h$ allows the measurement of nearly all common flow rates as a function of pipe diameter.

Measurements in larger pipe diameters are possible by using the push-in monitoring head CSF-11AM1.

#### 1.1.4.1 Consumption measurements

The FC100-CA with CSx- monitoring head is suitable for compressed air and other gases. Its electronic control unit comprises two freely scalable linearised analogue outputs, i.e. one for temperature, the other for mass flow, standard flow or operating volume flow. A pulse output and totalizer for consumption measurements are other added features. The FC100-CA also provides limit value monitoring of flow and temperature, ensuring reliable operation of the load.

#### 1.1.4.2 Leakage measurements

When monitoring compressed-air flow at some selected points during a production-free period, you will realise that even in carefully maintained compressed-air systems there is still compressed air consumed. Reliably detecting even the smallest of such leakage losses can be facilitated by means of the adjustable zero suppression of the FC100-CA. If the system is permanently monitored for leakage flow, leakages caused by valves left open etc. and new leakage points can easily be detected.

The FC100-CA also allows the detection of leakages on duty by comparing two equal loads with each other. The difference measured can be directly assigned to the leakage flow.

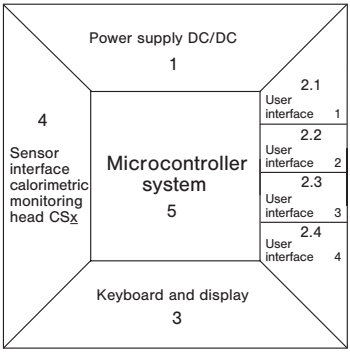
**Note:**

- Please see the accuracy specifications of FC100-CA with insertion head CSx.

## 1.2 System description

The system comprises the following hardware functional modules:

| | |
|---|---|
| 1 Input voltage | DC supply (terminal XV) |
| 2 User interfaces: | 2.1 signal outputs, 2-way or 4-way signal outputs (terminal XAH) |
| | 2.2 analogue outputs (terminal XAO) |
| | 2.3 RS232 interface (terminal XSE) |
| | 2.4 external totalizer reset (terminal XRE) |
| 3 Keyboard and display: | keypads |
| | liquid crystal display |
| 4 Sensor interface: | calorimetric monitoring head type CSx (terminal XSK) |
| 5 Microcontroller system: | signal processing, communication and monitoring |




| | | | |
|---|---|---|---|
| 1 | Input voltage: | DC 10 ... 40 V | |
| 2.1 | User interface 1: | relay outputs: | 2 limit values |
| | | transistor outputs: | 2 limit values + 1 error indication + 1 busy signal or pulse output (software selected) |
| 2.2 | User interface 2: | analogue outputs: | temperature and flow current or voltage |
| 2.3 | User interface 3: | RS232 interface | |
| 2.4 | User interface 4: | totalizer reset: | edge controlled potential free, normally open contact or voltage pulse DC10 ... 40 V |
| 3 | Keyboard/Display: | keypads<br>LC display<br>2 x 16 digits<br>backlight (can be switched off) | |
| 4 | Sensor interface: | calorimetric monitoring head type CSx | |
| 5 | Controller system: | signal processing<br>I/O - controlling<br>monitoring<br>parameter memory<br>communication | |

fig. 2

**The analogue outputs and the signal outputs are galvanically isolatated from the other electronics.**
The two analogue output channels are not galvanically isolated from each other.

There is no electrical isolation between power supply, controller system, sensor interface, monitoring head and RS232 interface.

The monitoring heads are connected by means of precut cables.

Cables and user interface connections are shown in chapters 2.2.2 and circuit diagrams 2.2.2.1/ 2.2.2.2/2.2.2.3.

System configuration and parameter settings can be modified by means of the keyboard if **default values** need to be changed (see chapter 5).

This mainly applies to monitoring head selection, signal outputs (switch point setting) and analogue outputs (zero point setting and scaling).

### 1.2.1 User interfaces

**Signal outputs:** (optional)

1. **R2** - Relay outputs (2 limit values)
   **Two-channel galvanic isolation**
   Contact Form: Single pole double throw (SPDT)
   The channels may be assigned in menu “CONFIGURATION”, either individually or in pairs, to the physical quantities of temperature or flow. The switch on and off values can be set as desired in menu “PARAMETERS” (yet within the measuring range) for each contact.
   Please see chapter 7.4.1 for electrical connection.

2. **T4** – Transistor outputs (2 limit values + 2 status outputs or 2 limit values + 1 status output + 1 pulse output)
   **Four-channel galvanic isolation**, transistor output (NPN) – collector/emitter freely connectable
   Channel 1: common error signal
   Channel 2: busy signal or pulse output
   Channels 3 and 4: Both channels may be assigned individually or in pairs to the physical quantities of temperature or flow. The switch on or off values of each transistor output can be set as desired.
   Please see chapter 7.4.2 for electrical connection.

**Analogue outputs**: **Galvanic isolation**, current or voltage output
Please see the ordering number to find out whether it is a current or voltage output.

| Output quantities: | 0/1 - 5 V FS | (option V1) |
|---|---|---|
| | 0/2 - 10 V FS | (option V2) |
| | 0/4 - 20 mA FS | (option C1) |

These FS (full scale) output quantities apply to both channels as standard.
20% zero elevation and FS value can be programmed. (see chapter 5.9)
Shield connections are ungrounded.

⚠ **The shields of the signal cables should be applied on one side only.**

**Power supply:**

DC 10 ... 40 V
Internal switched mode power supply with galvanic isolation of the primary and secondary side. The secondary side is short-circuit proof. There is a fuse on the primary side which can only be replaced by FlowVision.

**Noise emission is limited by appropriate circuit design and filters.**
**Pin XV1 (shield) is internally connected with Pin XV3 ($-U_V$).**
**The housing is connected to shield potential.**

Please see chapter 7.2 for technical characteristics.

# 2 Installation

## 2.1 Installation of calorimetric monitoring heads

These are general directions for the application of calorimetric measuring heads which from application to application should be reviewed by the user in accordance with individual requirements.

### 2.1.1 Selection of material

**Stainless steel 1.4571/AISI 316 Ti**
The standard monitoring head material is stainless steel 1.4571/AISI 316 Ti, an austenitic, acid-resisting stainless steel that is commonly used throughout industry. Manufacturers claim it also withstands oxidizing organic and anorganic acids, and partly even reductive media.

The resistance of this stainless steel should however be verified by the user, particularly when it is used in medium mixtures that may from time to time be exchanged with cleansing agents. Its chemical resistance also depends on temperature, flow rate and concentration of the medium.

Stainless steels owe their resistance to rust mainly to their alloy combination with chromium, the formation of chromic oxide on the steel surface resulting in a passive state. Contamination, deposits on the surface, or foreign rust may however neutralize the passivity. Therefore care should be taken to keep the surfaces clean.

Stainless steel heads must not get in contact with steel parts other than stainless steel or with chemically dissimilar metals, as this would cause electrolytic corrosion.

**Nickel-based alloy (Hastelloy 2.4610)**
Hastelloy 2.4610 is a material with a chemical resistance generally exceeding that of stainless steel. They are particularly suitable for alkaline media (pH > 7). They should however be examined for suitability for each specific application using resistance tables and empirical values.

## 2.1.2 Mechanical installation

### 2.1.2.1 Thread-mounted monitoring head CST-11

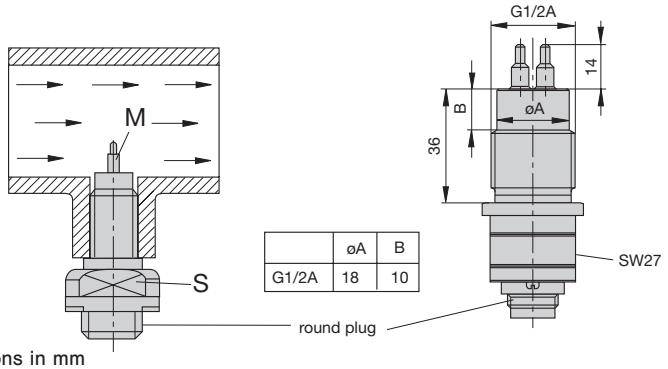
**Application:** general industry and installation

**Medium:** gases

**Styles:** G1/2A

**Materials of the area exposed to medium:** stainless steel 1.4571 /AISI 316 Ti (standard)
nickel-based alloy (Hastelloy C4 2.4610)

If installed in fittings or T pieces with appropriate internal thread the max. length of the connection piece should be 36 mm from the inner pipe wall.




| | øA | B |
|---|---|---|
| G1/2A | 18 | 10 |

All dimensions in mm

fig. 3

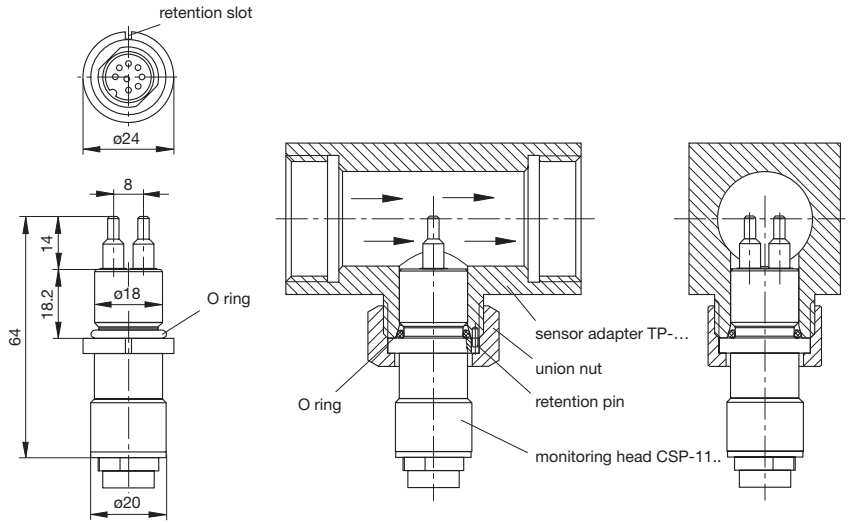
### 2.1.2.2 Insertion head CSP for sensor adapter TP- ... or ball valve BV- ...

**Application:** general industry and installation

**Style:** insertion-type for sensor adapter TP-... and ball valve BV-...

**Installation:** sensor adapter TP-.. (see fig. 5)
ball valve BV-.. (see fig. 6)

**Material of the area exposed to medium:** stainless steel 1.4571/AISI 316 Ti, electropolished
O-ring (viton)




All dimensions in mm

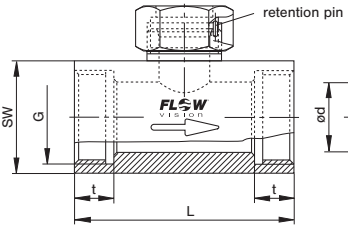
fig. 4

### 2.1.2.3 Sensor adapter TP- ...

The sensor adapter TP- ... is available in 6 pipe diameters from 1/2“ to 2“.

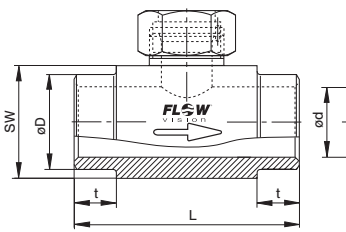
**Material of the area exposed to medium:**

- brass (not TP-03 ...) / gunmetall (only TP-03 ...) or
- stainless steel 1.4571/AISI 316 Ti




| Type | DN | ød | G | t | L | SW |
|---|---|---|---|---|---|---|
| TP-01 ... | 15 | 16 | 1/2" | 11 | 50 | 27 |
| TP-02 ... | 20 | 20 | 3/4" | 12 | 64 | 32 |
| TP-03 ... | 25 | 25 | 1" | 14 | 78 | 40 |
| TP-04 ... | 32 | 32 | 1 1/4" | 15 | 94 | 50 |
| TP-05 ... | 40 | 40 | 1 1/2" | 15 | 110 | 55 |
| TP-06 ... | 50 | 50 | 2" | 19 | 138 | 70 |

All dimensions in mm
unless otherwise specified

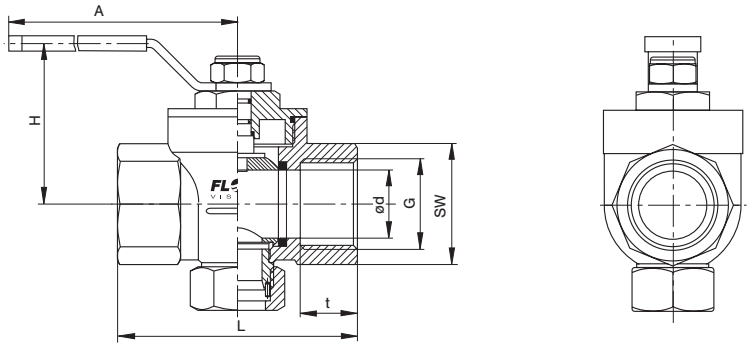



| Type | DN | ød | øD | t | L | SW |
|---|---|---|---|---|---|---|
| TP-01M1-S A | 15 | 16 | 21.3 | 15 | 50 | 27 |
| TP-02M1-S A | 20 | 20 | 26.9 | 15 | 70 | 32 |
| TP-03M1-S A | 25 | 25 | 33.7 | 15 | 80 | 40 |
| TP-04M1-S A | 32 | 32 | 42.4 | 15 | 100 | 50 |
| TP-05M1-S A | 40 | 40 | 48.3 | 15 | 110 | 55 |
| TP-06M1-S A | 50 | 50 | 60.3 | 15 | 140 | 70 |

fig. 5

### 2.1.2.4 Ball valve BV- ...

The ball valve is available in 4 pipe diameters from 1“ to 2“.
The ball valve ensures the sensors are fully immersed in the medium.
The monitoring head may also be replaced in pressurised pipe systems on duty.




All dimensions in mm
unless otherwise specified

| Typ | DN | ød | G | t | L | SW | H | A |
|---|---|---|---|---|---|---|---|---|
| BV-03M 3 | 25 | 25 | 1" | 21 | 88 | 41 | 59 | 115 |
| BV-04M 3 | 32 | 32 | 1 1/4" | 24 | 100 | 50 | 65 | 115 |
| BV-05M 3 | 40 | 40 | 1 1/2" | 24 | 110 | 54 | 77 | 150 |
| BV-06M 3 | 50 | 50 | 2" | 28 | 131 | 70 | 85 | 150 |

fig. 6

### 2.1.2.5 Push-in monitoring head CSF-11AM1/CSF-11AM2

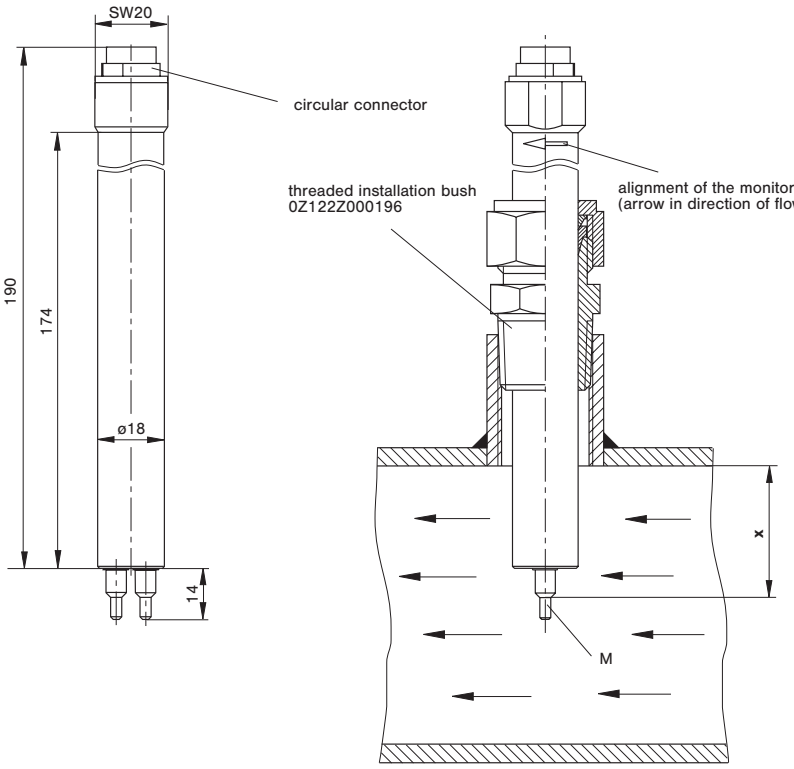
**Application:** general industry and installation
recommend for inside pipe diameter >60 mm

**Style:** push-in monitoring head

**Material of the area exposed to medium:**

stainless steel 1.4571/AISI 316 Ti

nickel-based alloy (Hastelloy C4 2.4610)



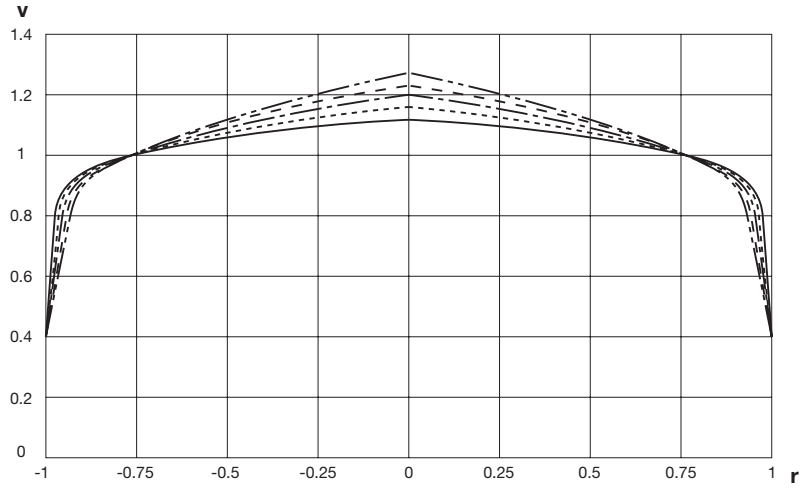

**x → 1/8 of the inside pipe diameter**

All dimensions in mm

fig. 7

**2.1.2.6 Standard velocity profiles:**

(for pipe radius = 1 and for velocity averaged via total pipe cross section = 1)




r - pipe radius
v - velocity

**Velocity range at X = 1/8 dia.**

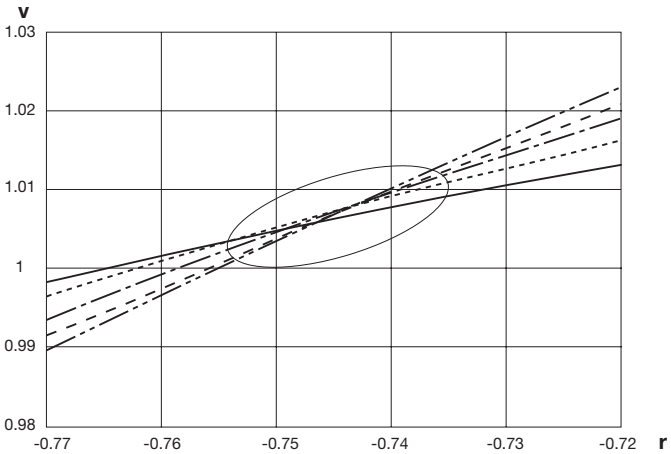



fig. 8

Max. accuracy is achieved with an insertion depth of x = 1/8 inside pipe diameter (see fig. 7).

### 2.1.3 Mounting instructions for monitoring head CST

**Caution!**

The two sensors (M) should be screwed into the pipe far enough to ensure that they are aligned side by side directly across the direction of flow. The sensors are correctly positioned when the wrench flats (S) are aligned parallel to the pipe.
The sensors must be positioned fully in the flow stream.

**The surface of the shaft end must not be recessed below the inner pipe wall. Preferably the shaft surface of the monitoring head should project approx. 1-2 mm towards the pipe centre.**

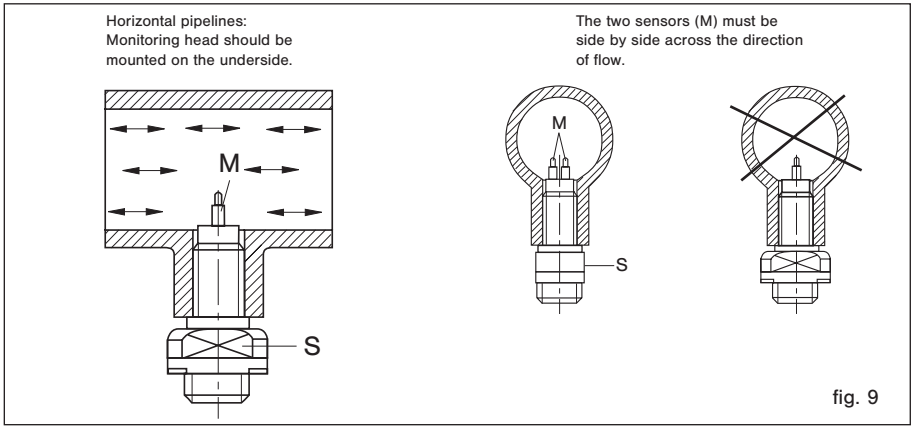



fig. 9

#### 2.1.3.1 Depth of immersion

For inside pipe diameters up to 56 mm shaft end should be in line with the inner pipe wall.

For inside pipe diameters more than 56 mm the shoulder of the two sensors (7 mm from the tip) should be positioned at 1/8 of inside pipe diameter Øi (see fig. 10).

Example: Mounting for an inside pipe diameter of 200 milimeters.

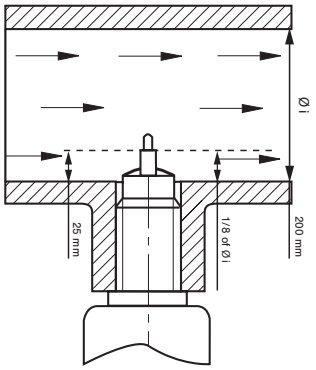



fig. 10

For sealing use hemp, teflon tape or thread sealing glue.

### 2.1.4 Mounting instructions for monitoring head CSP-... with sensor adapter TP-...

**Caution!**

The monitoring head should only be installed or removed when the pipes are unpressurised.

The safety label must be clearly visible, it should be affixed onto or close to the metering point.

- Insert the monitoring head with the O-ring into the sensor adapter and tighten the union nut (observe correct retention) (see fig. 4).

  The retention pin ensures correct alignment of the monitoring head after the union nut has been tightened.

  Correct immersion depth of the monitoring head is ensured by the stop provided.

  Sealing of the monitoring head in the sensor adapter is ensured by means of the O-ring (see fig. 4).

- Screw the sensor adapter into the pipe. Use hemp, teflon tape or thread sealing glue for sealing.

### 2.1.5 Mounting instructions for push-in monitoring head CSF-...

**Caution!**

The two sensors (M) (see fig. 7) should be screwed into the pipeline far enough to ensure that they are aligned side by side directly across the direction of flow. The sensors are correctly positioned when the wrench flats are aligned parallel with the pipeline.

**The shoulder of the sensor (7 mm from the tip) must be at the position 1/8 of the inside pipe diameter Ø i (see fig. 11).**

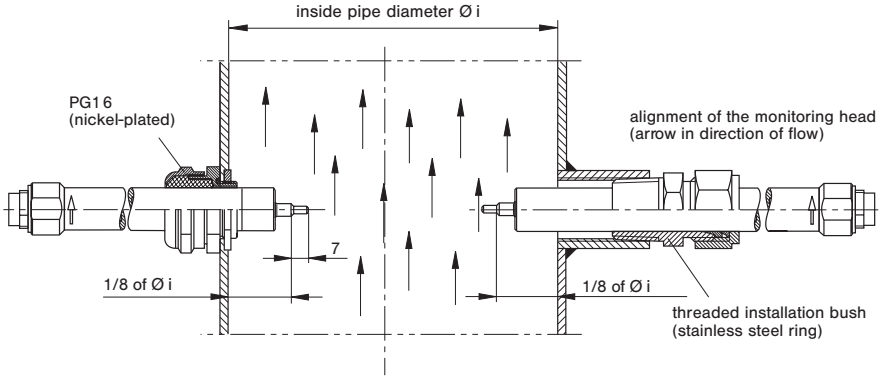



fig. 11

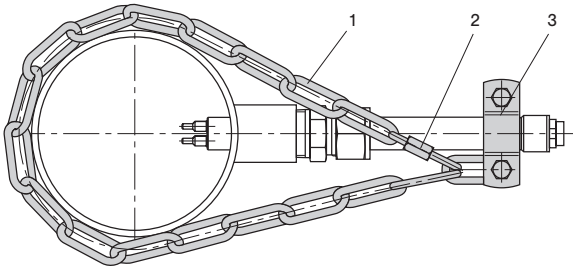
Fit monitoring head with locking set (see fig. 12):

- Fix first link of chain (1) into the clip (3).
- Put chain catch (2) into link and fasten with the tight chain.

**Caution!**

**Check locking system with regard to strength!**
**The locking chain must be mounted as tightly as possible.**

**Locking set 01**
0Z122Z000204




1 chain 4 x 32 DIN 5685 (approx. 1 m)
2 catch for chain NG 5
3 clip with screws and nuts DN15 to DIN 11850
(tightening torque 10 Nm)

fig. 12

### 2.1.6 Point of installation and steadying zones

The mounting attitude is unimportant. It is generally sufficient to have a distance of 10 pipe diameters (D) before the monitoring head without any bends and changes in pipe diameter if the velocity profile is only slightly disturbed. For heavily disturbed velocity profiles, above all for a superimposed swirl-flow, there should be a distance of 20 ... 50 pipe diameters (D) before the monitoring head in order to eliminate high deviations of the measured values.

**It is generally recommend to observe the following distances (see fig. 13):**

- distance before the monitoring head without any bends and changes in pipe diameter: **15...20xD**
- distance after the monitoring head without any bends and changes in pipe diameter: **5 x D**

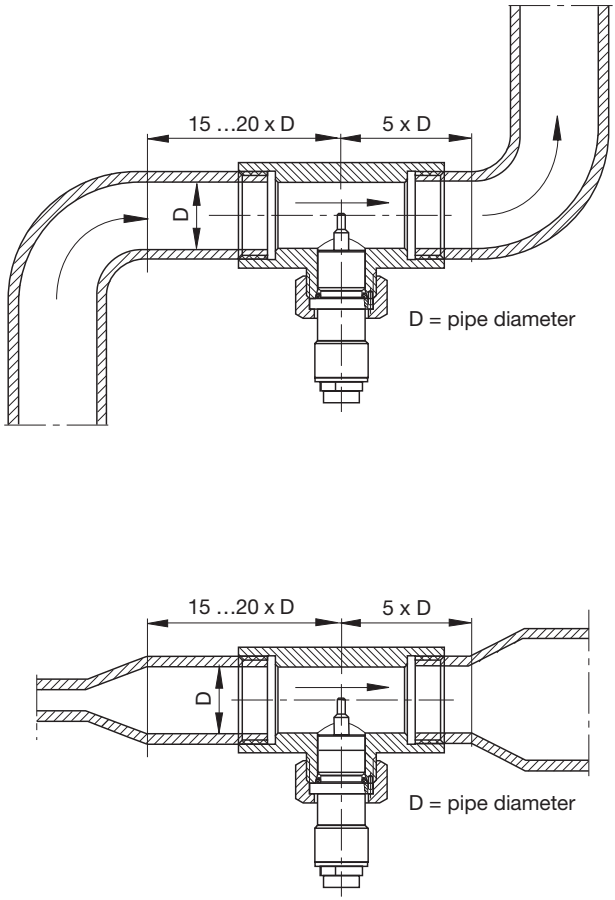



fig. 13

### 2.1.7 Condensate deposits

Oil or water deposits on the sensors may falsify the measuring results. Such deposits must be expected, for example, when high flow velocities of compressed air are concerned and there is no drying provided. Normal condensation on an unheated sensor is normally not detected. It will dry after a few minutes. Deposits on heated sensors only occur at high air humidities and will cause significant measuring errors. In most cases, such deposits will dry within a few minutes.

Deposits of oil, however, will not dry and should be removed at regular intervals.

### 2.1.8 Electrical connection

**Cable Do + Ka type xx**
(depends on FC100-CA version)

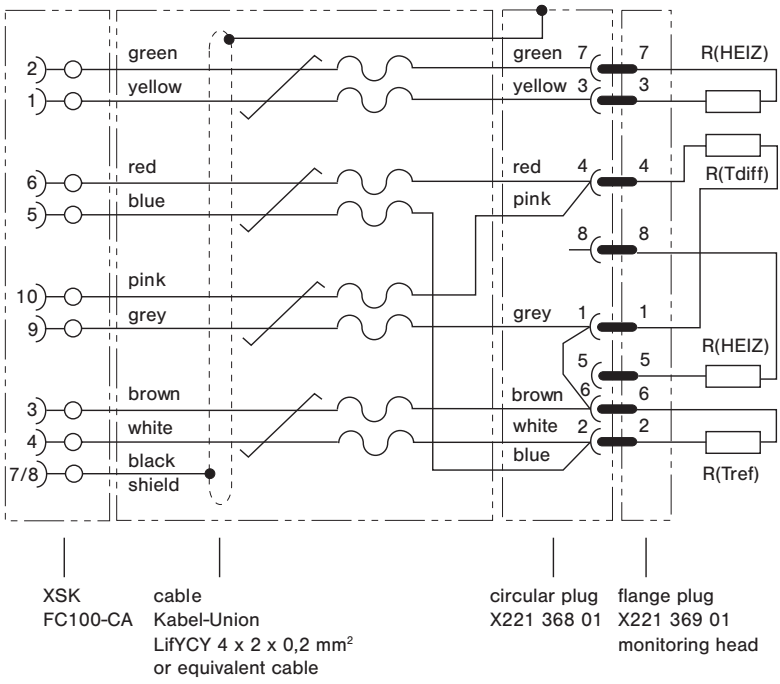



fig. 14

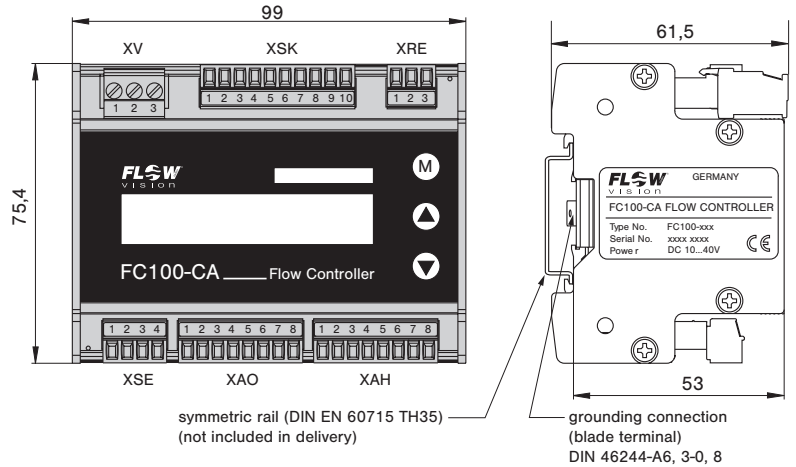
## 2.2 Installation of electronic control unit FC100-CA

### 2.2.1 Mechanical installation

#### 2.2.1.1 Rail-mounted version FC100-CA-U1... (see fig. 15)

- The electronic housing is mounted on a symmetric (35mm) rail to DIN EN 60715 TH 35 (formerly EN 50022).
- There is no need for space between several modules.
- Removal is by releasing the spring catch.

FC100-CA (rail mounted version)



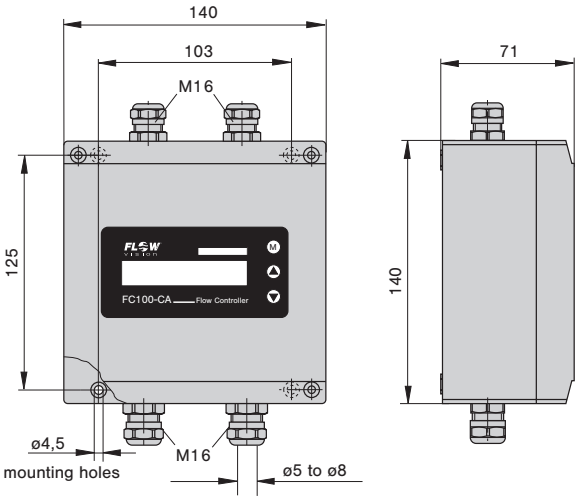

All dimensions in mm

fig. 15

**2.2.1.2 Surface mounted version FC100-CA-FH-U1...** (see fig. 16)

- Remove the cover of the housing.
- Install the housing in place using the 4 screws M4.
- Replace the cover and tighten the retaining screws.

FC100-CA-FH (surface mounted version)




All dimensions in mm

fig. 16

### 2.2.2 Electrical connection

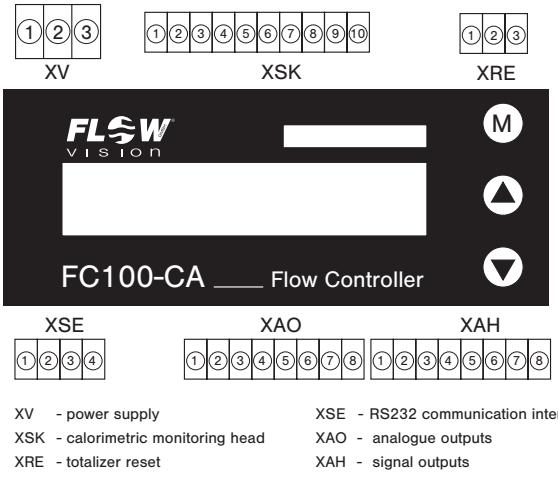
Valid for all plug-in screw terminal strips (XV, XSK, XRE, XSE, XAO, XAH):

Cable size: 0.14 $mm^2$ to 1.5 $mm^2$, single or finely stranded conductor

**XV – Power supply**

Connection: 3 pole plug-in screw terminal strip

| Pin No. | Signal name | Function |
|---|---|---|
| 1 | SGND | general reference ground/shield ground |
| 2 | $+U_V$ | positive pole of supply voltage |
| 3 | $-U_V$ | negative pole of supply voltage |




XV - power supply
XSK - calorimetric monitoring head
XRE - totalizer reset
XSE - RS232 communication interface
XAO - analogue outputs
XAH - signal outputs

fig. 17

**XAO - Analogue outputs (option: V1, V2, C1)**

Connection: 8 pole plug-in screw terminal strip

| Pin No. | Signal name | Function |
|---|---|---|
| 1 | nc | none |
| 2 | ANAO1 | analogue output 1 - flow |
| 3 | ANA1GND | reference potential for analogue output 1 |
| 4 | SGNDA1 | shield connection for analogue output 1 (ungrounded) * |
| 5 | SGNDA2 | shield connection for analogue output 2 (ungrounded) * |
| 6 | ANAO2 | analogue output 2 - temperature |
| 7 | ANA2GND | reference potential for analogue output 2 |
| 8 | nc | none |

*** Apply shield on one side only.**

**XAH - Limit switch signal outputs - relay outputs - single pole double throw**

Connection: 8 pole plug-in screw terminal strip

| Pin No. | Signal name | Function |
|---|---|---|
| 1 | SGNDL1 | shield ground 1 |
| 2 | LIM1 | non-inverted signal output 1 (N.O.) |
| 3 | LIM1COM | common 1 |
| 4 | /LIM1 | inverted signal output 1 (N.C.) |
| 5 | SGNDL2 | shield ground 2 |
| 6 | LIM2 | non-inverted signal output 2 (N.O.) |
| 7 | LIM2COM | common 2 |
| 8 | /LIM2 | inverted signal output 2 (N.C.) |

**XAH - Limit switch signal outputs - transistor outputs NPN, freely connectable as emitter (-) and collector (+) have been led out separately.**

Connection: 8 pole plug-in screw terminal strip

| Pin No. | Signal name | Function |
|---|---|---|
| 1 | /ERROR E | summarized error indication - emitter terminal |
| 2 | /ERROR C | summarized error indication - collector terminal |
| 3 | /BUSY/PULSE E | availability signal or pulse output - emitter terminal |
| 4 | /BUSY/PULSE C | availability signal or pulse output - collector terminal |
| 5 | LIM2 E | limit value 2 - emitter terminal |
| 6 | LIM2 C | limit value 2 - collector terminal |
| 7 | LIM1 E | limit value 1 - emitter terminal |
| 8 | LIM1 C | limit value 1 - collector terminal |

**XSK - Connection of calorimetric monitoring heads type CSx**

Pre-sized connecting cable Do+Ka type 15 or Do+Ka type 18 with plug-in screw terminal strip (see chapter 2.1.8)

**XSE - Communication interface RS232**

Connection: 4 pole plug-in screw terminal strip

| Pin No. | Signal name | Function |
|---|---|---|
| 1 | TXD | RS232 transmitter |
| 2 | RXD | RS232 receiver |
| 3 | GND | ground |
| 4 | SGND | shield ground |

**XRE - external totalizer reset**

Connection: 3 pole plug-in screw terminal strip

Examples of connection: see fig. 22 and 23.

### 2.2.2.1 Circuit diagram FC100-CA (relay outputs)

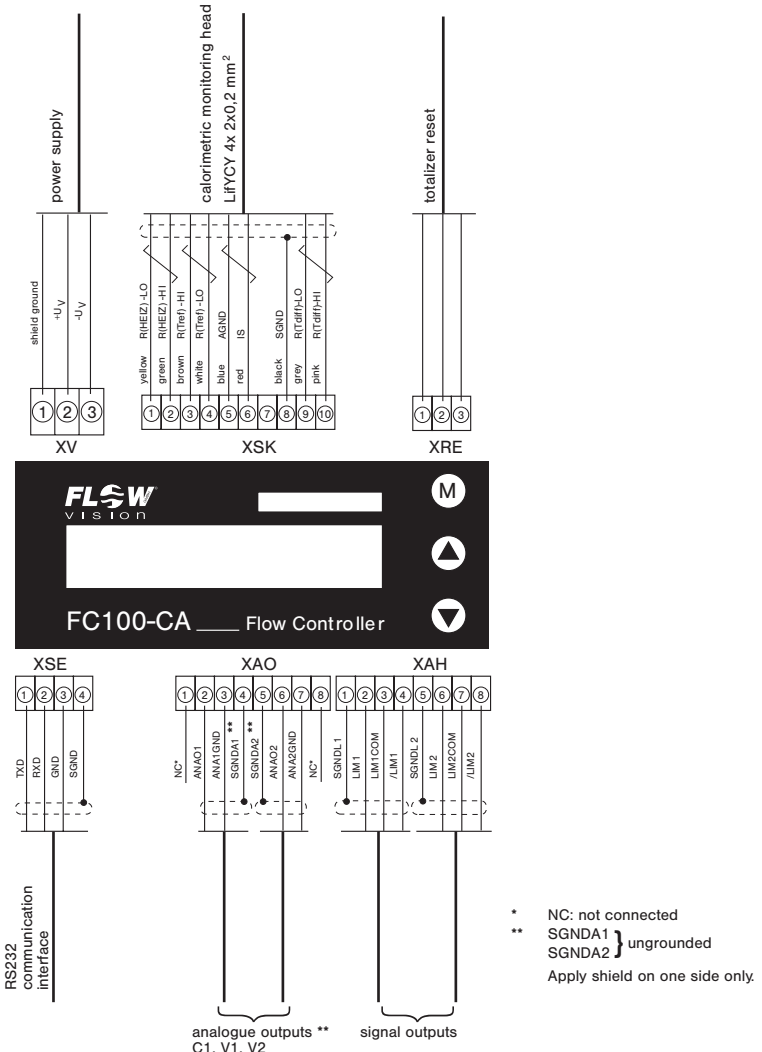



fig. 18

### 2.2.2.2 Circuit diagram FC100-CA (transistor outputs (NPN))

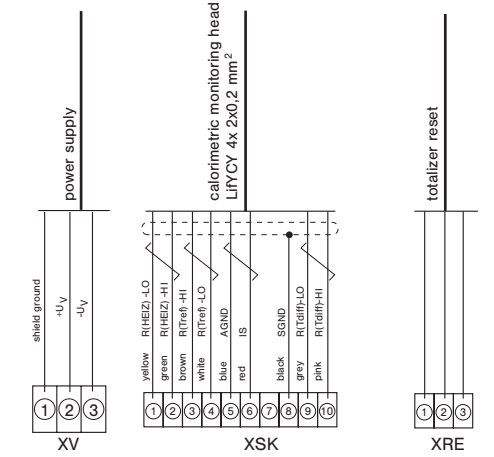



fig. 19

### 2.2.2.3 Electrical connection - pulse output (version FC100-CA-U1T4...)

The quantity-dependent pulse may be selected in the menu item “USER OUTPUTS” (see chapter 5.9). A square pulse signal is available for driving a counter of a primary control at the plug **XAH** / BUSY E/- and /BUSY C/+ (pins 3 and 4) (see fig. 19 - circuit diagram FC100-CA - transistor outputs).

Signal ground shall be connected to pin 3 (BUSY E/-) and the driving load to pin 4 (BUSY C/+).

The pulse length is 50 ms (±1%) continuously.

Select cable size ≤1.5 mm$^2$ to make the connections.

**Electronic signal processing** (see fig. 20)

If the frequency output of the FC100-CA is connected to an electronic counter, computer or PLC, the load current should not exceed 10 mA to ensure low level is 0.8 V.

**Typical circuit (example 1)**

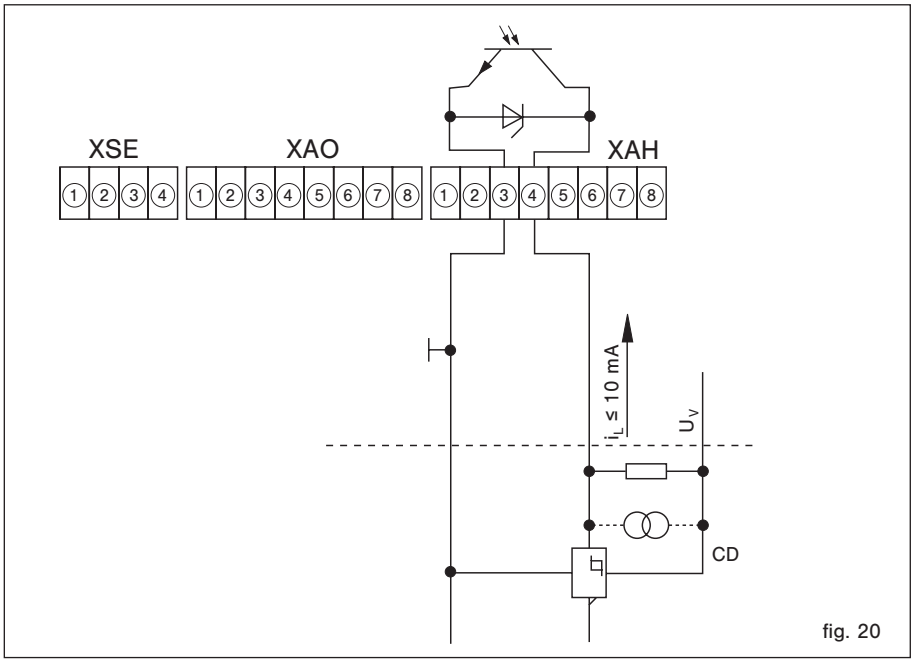



fig. 20

**Electromechanical pulse counter** (see fig. 21)

The FC100-CA driver output comprises an integral safety circuit which when isolating the counter operating coil will limit overvoltages caused by inductance.

The counter should be able to process a counting frequency of **≥10 Hz** as the pulse length is 50 ms (±1%) continuously.

It should therefore be ensured that the counter can be increased by one during the time available

If a separate relief network is preferred to the integral network, care should be taken when processing the max. frequency of 10 Hz to ensure the energy stored in the operating coil has dissipated by the time the counter output is switched on again. The time to do this should be below 40 ms, making due consideration to switching times and pulse variations.

**Typical circuit (example 2)**

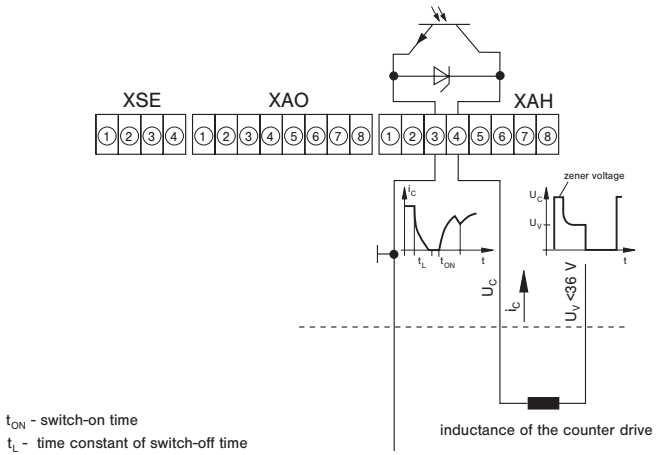



fig. 21

**Note:**

- As there will be a reset pulse available at the output in the moment the supply voltage of the FC100-CA is applied, make sure that the counter is switched on delayed or set to zero after it has been switched on.

### 2.2.2.4 Electrical connection - totalizer reset

The FC100-CA has an external totalizer reset. The control signal is connected to plug **XRE**.

The totalizer reset is edge controlled – it is performed when the signal changes from low to high level.

There are two possible operating modes (see fig. 22 and 23).

**Operating mode 1**

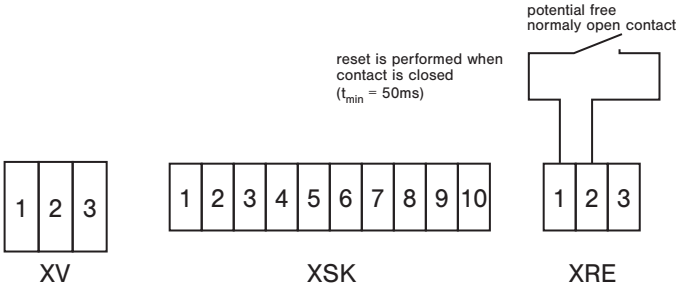



fig. 22

**Operating mode 2**

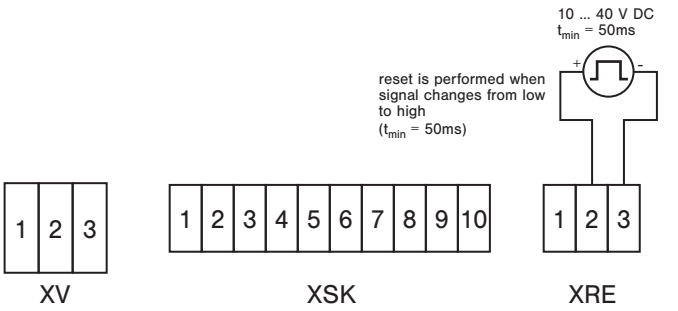



fig. 23

**Note:**

Pin XRE/1 is connected to pin XV2 ($+U_V$).

The input resistance of pin XRE/2 is 3kΩ.

Pin XRE/3 is connected to pin XV3 ($-U_V$).

## 3 Operating system

Clear menu-driven control, via keyboard and display, enables easy definition of parameters and configuration. This provides high system flexibility, making the FC100-CA the optimum solution for a wide variety of measuring, monitoring and display tasks.

When programming the FC100-CA the user is guided by plaintext in the display through menus in which he may enter or select the required functions.

Setting and configuration is by means of three front keys (M) MODE, (▲) UP and (▼) DOWN (see fig. 24).

It is also required for setting the unit to simultaneously press (▲) UP and (▼) DOWN = (▲ + ▼).

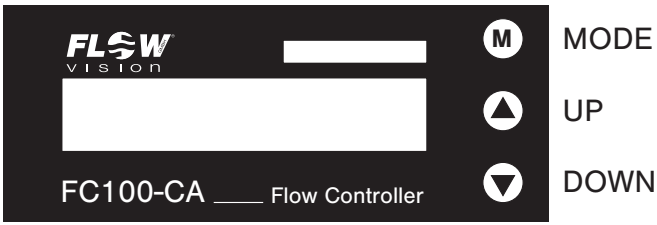



fig. 24

**Menu paging**

The next menu option is selected by pressing (M) MODE (forward paging).

**Calling a menu option**

Simultaneously pressing (▲) UP and (▼) DOWN = (▲ + ▼) calls the selected menu option or causes skipping to the selected submenu.

**Entry of numerals**

Some menu options require numerical values to be entered. After selecting the appropriate menu option, the value indicated can be changed by pressing (▲) UP or (▼) DOWN.

Each time (▲) UP or (▼) DOWN are pressed, the value indicated will be increased and reduced respectively, by one numeral skip.

The longer (▲) UP or (▼) DOWN are pressed, the faster the increase or reduction.

**Transfer of entries**

Pressing (M) MODE transfers the set value or the selected menu option to a volatile memory.

A permanent transfer of settings and values is only effected when quitting the menu, after a plausibility check of all entries.

Afterwards the data are still available even after repeatedly switching the FC100-CA ON/OFF.

**Deleting data**

Selected data such as MIN or MAX values can be deleted or reset by simultaneously pressing (▲) UP and (▼) DOWN = (▲ + ▼).

# 4 Operation and main menu

## 4.1 Switch-on performance

Upon power application **POWER-ON TEST** will be shown on the display for approx. 2 sec., with the **software version number** being indicated in the second line.

During this period, the integral controller will conduct test routines (see chapter 6.1, Test and diagnosis).

If no error was found during the test, the display will indicate **HEATING UP**. In the second line the remaining time will be displayed until the FC100-CA will start measuring.

## 4.2 Measuring cycle

Upon completion of the heating up period the display will change to measuring cycle, and the user interfaces such as analogue outputs or limit switches will be updated.

**Note:**

- It is not possible to configure the system during the measuring operations!

All options of the main menu, the peak-value menu and the information menu may be addressed and all functions of these menus may be used without affecting the measuring and monitoring function.

**Over limits of the measuring range**

Theoretically established measuring values will be used when the measuring range of calorimetric monitoring heads is exceeded (0 ... 68 m/s). The FC100-CA can thus be operated beyond the measuring values defined, i.e. up to 100 m/s when measuring the velocity of air.

Above 100 m/s the error message „ERROR 30“ indicates exceeding of the display range.

This feature will not affect the accuracy specified for the measuring ranges defined. No accuracy information can be given for conditions where the measuring ranges are exceeded.

Analogue output, limit switches etc. can be set beyond the measuring range. When percent display is selected, the defined measuring range will correspond to 0 ... 100% (>100% when the defined range is exceeded).

If the measuring range is exceeded “^” will be indicated behind the measuring value on the display.

**Measured value(s)**
Flow velocity, medium temperature, flow rate or totalized flow rate may be shown on the display in the unit selected.

## 4.3 Measuring Operation

The structure of the menu is shown below. All menu items are described on the following pages.

**Main menu**

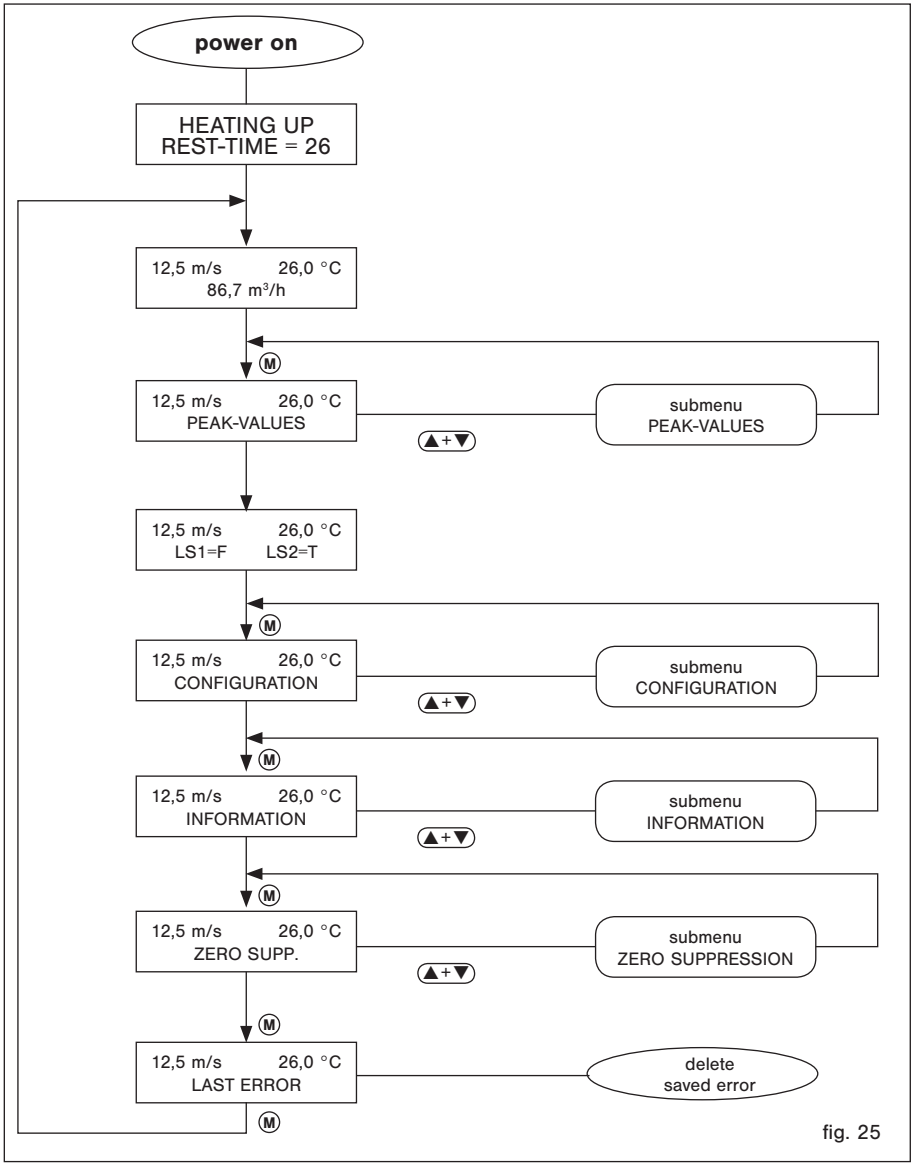



fig. 25

### 4.3.1 Peak values

The FC100-CA comprises six specific measured-values memories which may be retrieved in submenu PEAK-VALUES.

They store the lowest and highest value of flow velocity, medium temperature and volume flow.

After switch-on or NOT-BUSY indication, the minimum and maximum values are deleted and will be continuously updated (non-return pointer principle).

The peak values may be deleted by simultaneously pressing ▲ UP and ▼ DOWN = (▲ + ▼).

**Caution!**

⚠ **Power failure or disconnection of the power supply will delete the contents of the six measured-values memories.**

| MAX VALUES |
|---|
| flow velocity |
| medium temperature |
| volume flow |

| MIN VALUES |
|---|
| flow velocity |
| medium temperature |
| volume flow |

fig. 26

**Submenu PEAK-VALUES**

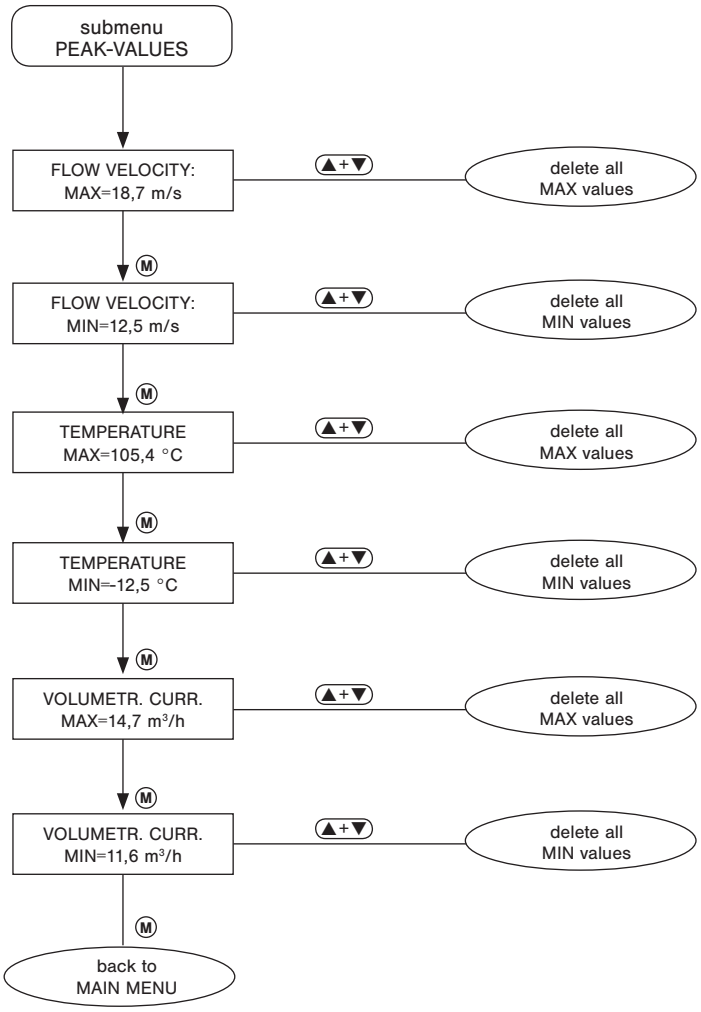



fig. 27

### 4.3.2 Limit switches

The next menu item shows the limit switches which are assigned to the physical quantity/quantities. **F** means the limit switch (LS) is assigned to flow velocity, **T** means the limit switch is assigned to medium temperature.

An inverse representation of **T** or **F** indicates that the limit switch is in switch-on condition.

### 4.3.3 Configuration

The submenu CONFIGURATION is described in chapter 5.

### 4.3.4 Information

The submenu INFORMATION shows the device type, the version of the firmware and the selected type of the monitoring head.

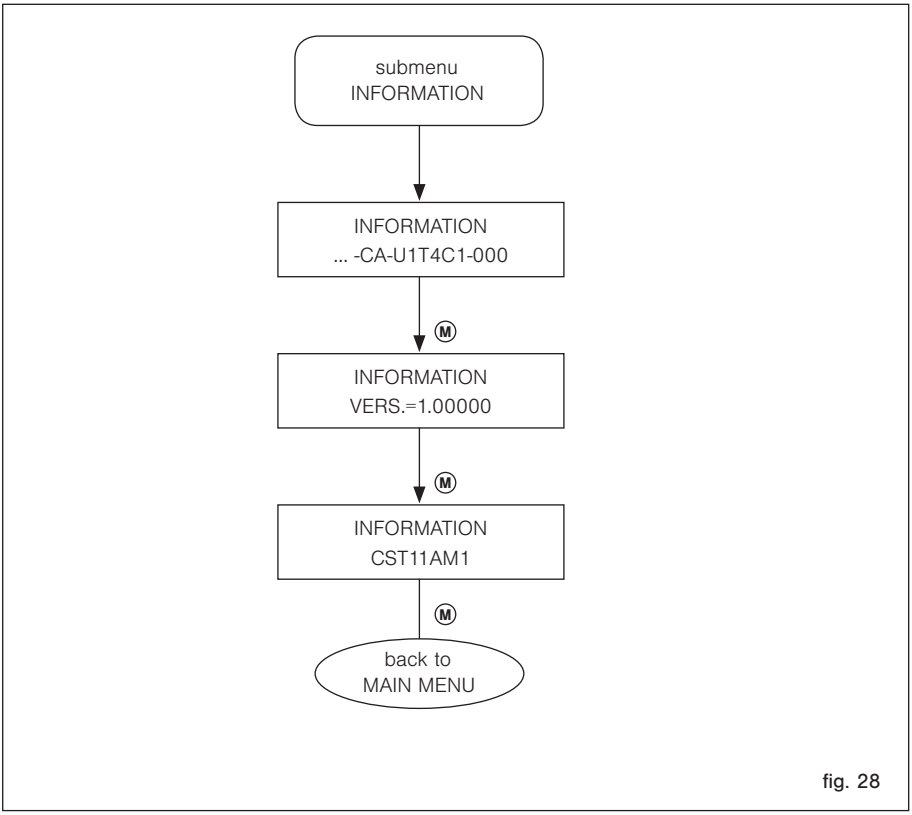



fig. 28

### 4.3.5 Low flow suppression and zero alignment

**Low flow suppression**

The low flow suppression serves to suppress small flow quantities and to detect leakages. The low flow suppression option ranging from 1 to 10 % of the measuring range final value can be used to eliminate false measurements as may arise upon (small) reverse flow quantities, for example. If flow velocity is less than the value set, the flow velocity and the applicable flow is set at zero. This also applies to all subsequent quantities such as analogue output and limit switches which are defined in the other menus.

**Zero alignment**

Although because of its very special characteristic curve in the lower flow range the calorimetric procedure implies a higher resolution than other measuring procedures, it is not possible to exactly measure zero flow. The reason for this is that in the lower flow range (<1 % of measuring range final value) current flow is superimposed by convection flow around the heated monitoring head sensor. Convection flow is very difficult to theoretically detect for all measuring systems (monitoring head and FC100-CA); it is determined by installation, current pressure, temperature, etc..

To ensure correct zero alignment, the pipeline should be operated under the desired pressure and temperature conditions. A waiting period of approx. 2 ... 5 minutes should be observed after the pipe system has been closed (zero volume flow) to ensure correct alignment. If the FC100-CA indicates flow after pipeline has been opened, there is definitely flow available.

To start zero alignment MIN. FLOW = 00% has to be selected in submenus ZERO SUPPRESSION.

After this adjustment even smallest volume flow quantities can be reliably indicated.

**Caution!**

⚠ No plausibility test to ensure there is no volume flow is conducted for zero alignment. The volume flow available at that time is set at zero. This should be considered above all for untight valves. In this case the zero volume flow determined this way may even be greater than 1 %. Accuracy in the lower measuring range will decrease then. To be on the safe side, the lower limit should therefore be set at 1 % if no reliable zero adjustment can be made.

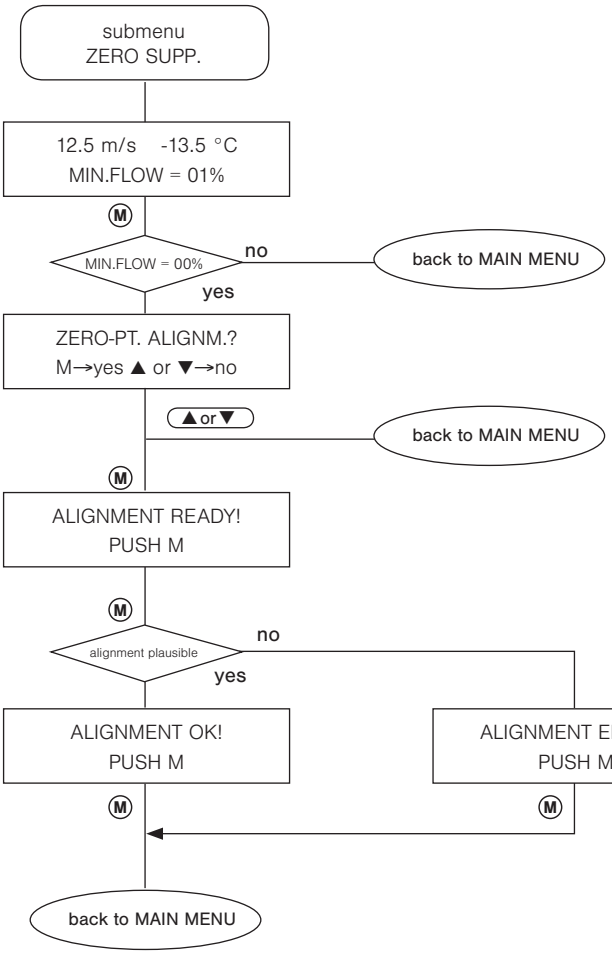



fig. 29

### 4.3.6 Last error

The last main menu option to be called is the error memory.

This error memory comprises the number of the last error (see chapter 6.2). It may be very helpful when commissioning the FC100-CA.

Other than the peak value memories described in chapter 4.3.1, the contents of this memory will be retained even upon power failure.

The user may purposely delete the error memory in the condition selected by simultaneously pressing (▲) UP and (▼) DOWN = (▲ + ▼).

## 5 Configuration

The CONFIGURATION submenu serves to adjust the FC100-CA to its application. During system configuration, measuring operations are not possible (see appendix 1).

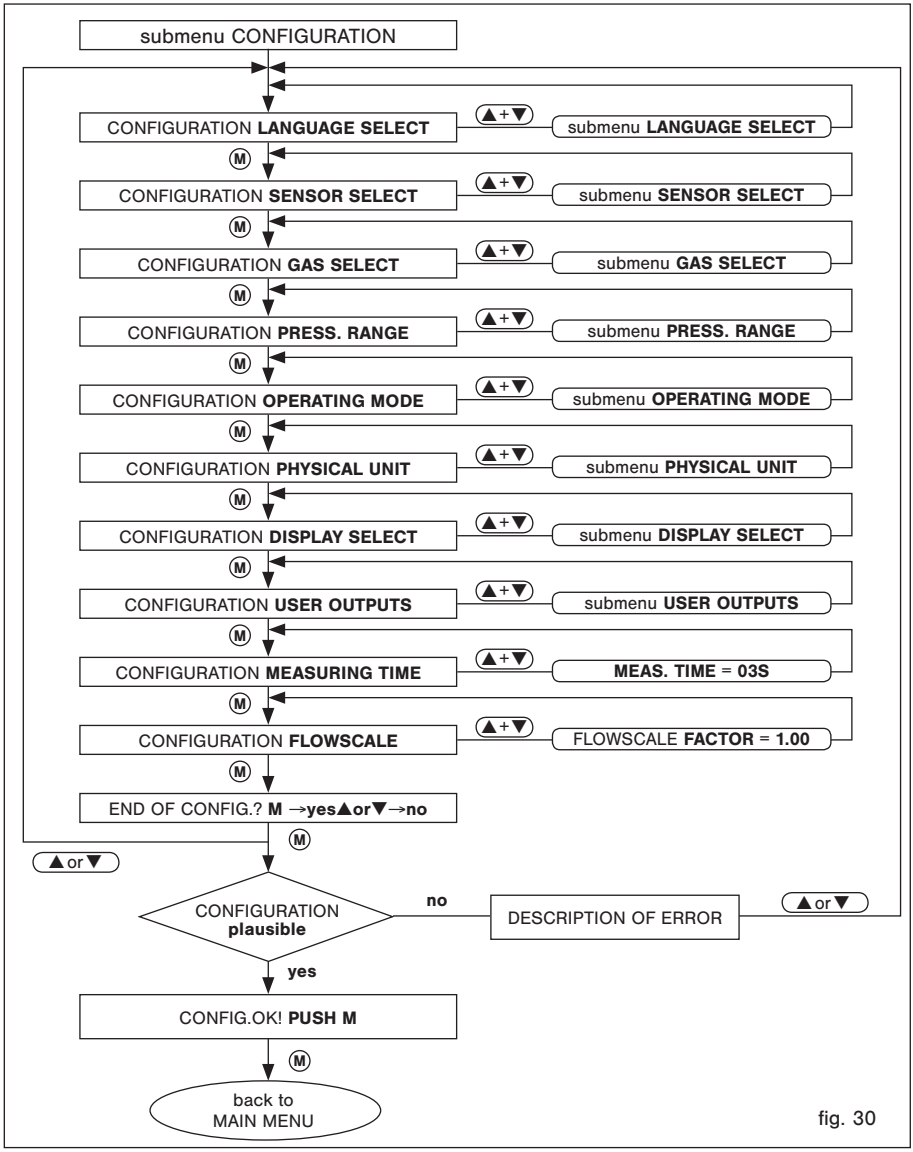



fig. 30

## 5.1 Language select

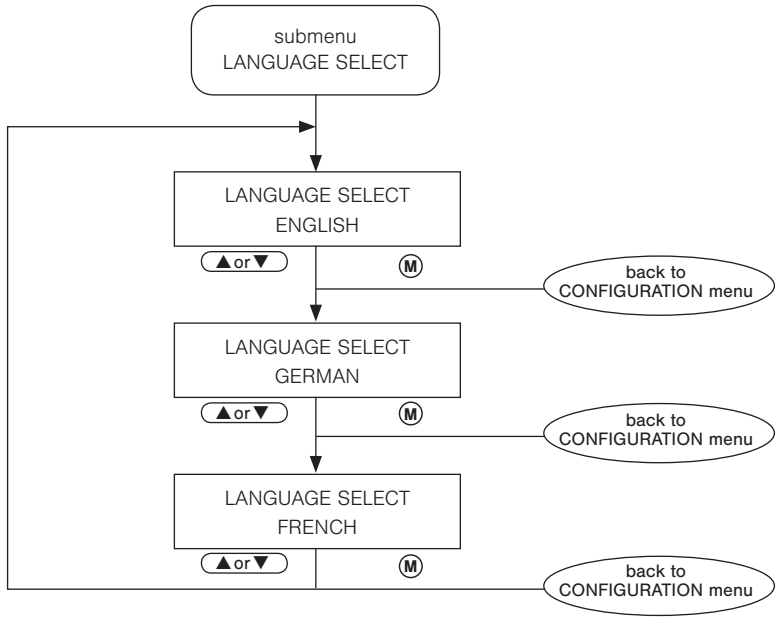
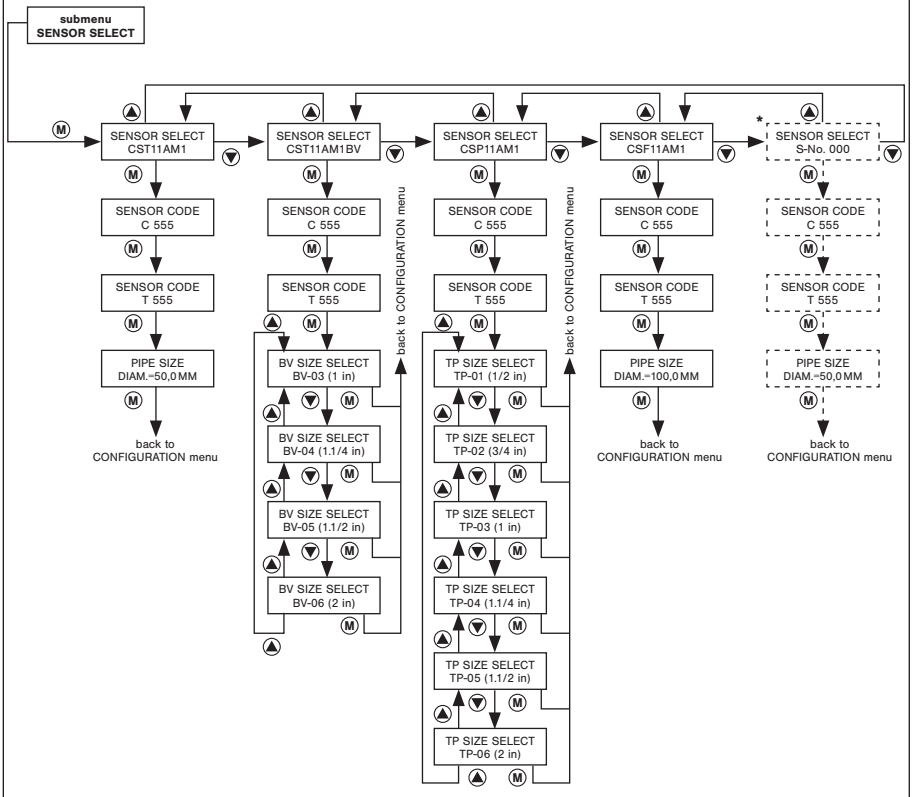



fig. 31

The menu language can be changed in the submenu. It is possible to choose ENGLISH, GERMAN or FRENCH (see fig. 31).

## 5.2 Sensor select


submenu
SENSOR SELECT
SENSOR SELECT CST11AM1
SENSOR SELECT CST11AM1BV
SENSOR SELECT CSP11AM1
SENSOR SELECT CSF11AM1
* SENSOR SELECT S-No. 000
SENSOR CODE C 555
SENSOR CODE T 555
PIPE SIZE DIAM.=50,0 MM
back to CONFIGURATION menu
BV SIZE SELECT BV-03 (1 in)
BV SIZE SELECT BV-04 (1.1/4 in)
BV SIZE SELECT BV-05 (1.1/2 in)
BV SIZE SELECT BV-06 (2 in)
TP SIZE SELECT TP-01 (1/2 in)
TP SIZE SELECT TP-02 (3/4 in)
TP SIZE SELECT TP-03 (1 in)
TP SIZE SELECT TP-04 (1.1/4 in)
TP SIZE SELECT TP-05 (1.1/2 in)
TP SIZE SELECT TP-06 (2 in)
PIPE SIZE DIAM.=100,0 MM
PIPE SIZE DIAM.=50,0 MM

*Only avaiable when a custom designed option has been ordered and integrated.

fig. 32

The SENSOR SELECT menu allows the selection of the monitoring head types suitable for compressed air applications, that can be used with the FC100-CA.

- TYPE CST-11AM1 thread-mounted head
- TYPE CSP-11AM1BV insertion head with ball valve BV-...
- TYPE CSP-11AM1 insertion head with sensor adapter TP- ...
- TYPE CSF-11AM1 push-in monitoring head
- TYPE S-No. xxx custom designed monitoring head

Enter the following characteristics when selecting the **monitoring head**. These **C** and **T** values ensure the exchangeability of the monitoring heads. The setting is menu driven:

1. SENSOR CODE C xxx range: **001 ... 999**
2. SENSOR CODE T xxx range: **500 ... 999**

These characteristics are marked on the monitoring head.

**Caution!**

⚠ It is important to observe correct settings after the monitoring head or the FC100-CA has been replaced as they have a major influence on measuring accuracy.

## 5.3 Pipe size

When using CST-11AM1 or CSF-11AM1 monitoring heads pipe diameter assignment as required for volume flow measurements should also be entered.

Pipe size range: 10.0 ... 999.9 mm

## 5.4 Gas selection

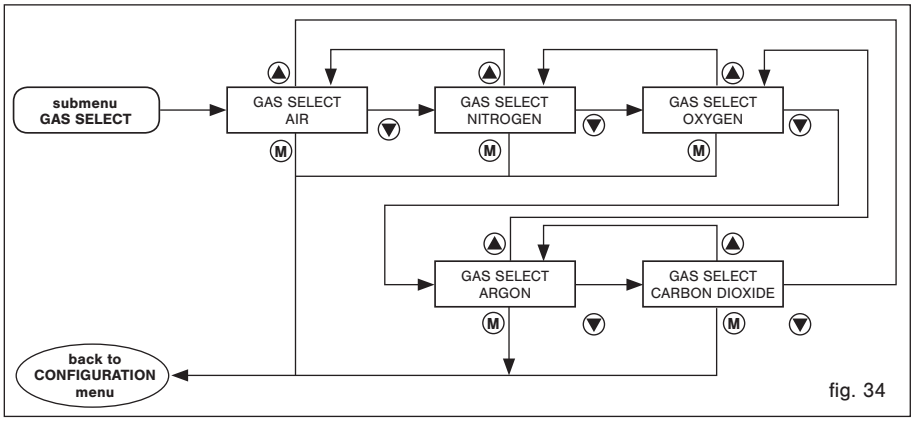


fig. 34

This menu option allows the selection of the following gases:

- air
- oxygen $O_2$
- nitrogen $N_2$
- carbon dioxide $CO_2$
- argon Ar

Individual gas density is taken into account when calculating mass flow of these gases (see chapter 5.7).

Standard densities at 1013 bar/14.69 psi and 0 °C/32 °F:

- air 1.293 kg/Nm$^3$
- oxygen 1.429 kg/Nm$^3$
- nitrogen 1.250 kg/Nm$^3$
- carbon dioxide 1,977 kg/Nm$^3$
- argon 1,784 kg/Nm$^3$

For the medium carbon dioxide ($CO_2$) a characteristic curve determined in our lab has been stored, which has only been released for the sensor adapters TP01 ... TP04.

This menu option allows the addition of other gases as required by customer.

## 5.5 Pressure range

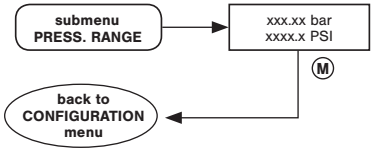



fig. 35

Pressure indication serves to correct the measured value and to convert standard volume flow to operating volume flow (see chapter 1.1.3).

Setting range: **0.10 ... 250** bar / **1.45 ... 3626** psi (absolute pressure)

**Caution!**

⚠ It is imperative to consider the approved pressure resistance of the sensors and adapters used.

## 5.6 Operating mode

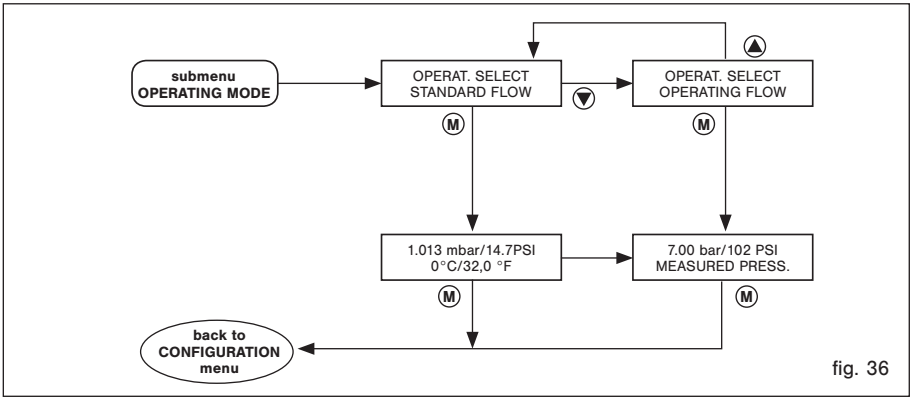



fig. 36

Volume flow can be indicated either as:

- STANDARD FLOW — Standard volume flow equals operating volume flow at 1013 mbar/ 14.69 psi and 0 °C/32 °F

or as

- OPERATING FLOW — Operating volume flow is calculated by the standard volume flow, considering the pressure set (see chapter. 5.2) and the medium temperature

The physical details are described in chapter 1.1, “Measuring procedure”.

The following volume flow and velocity values and those indicated on the display are set to standard or operating conditions by this setting.

**Caution!**

⚠ As under normal operating conditions pressure changes may arise, which cannot be taken into account when calculating operating volume flow, it is recommend to prefer the standard flow setting.

## 5.7 Physical units

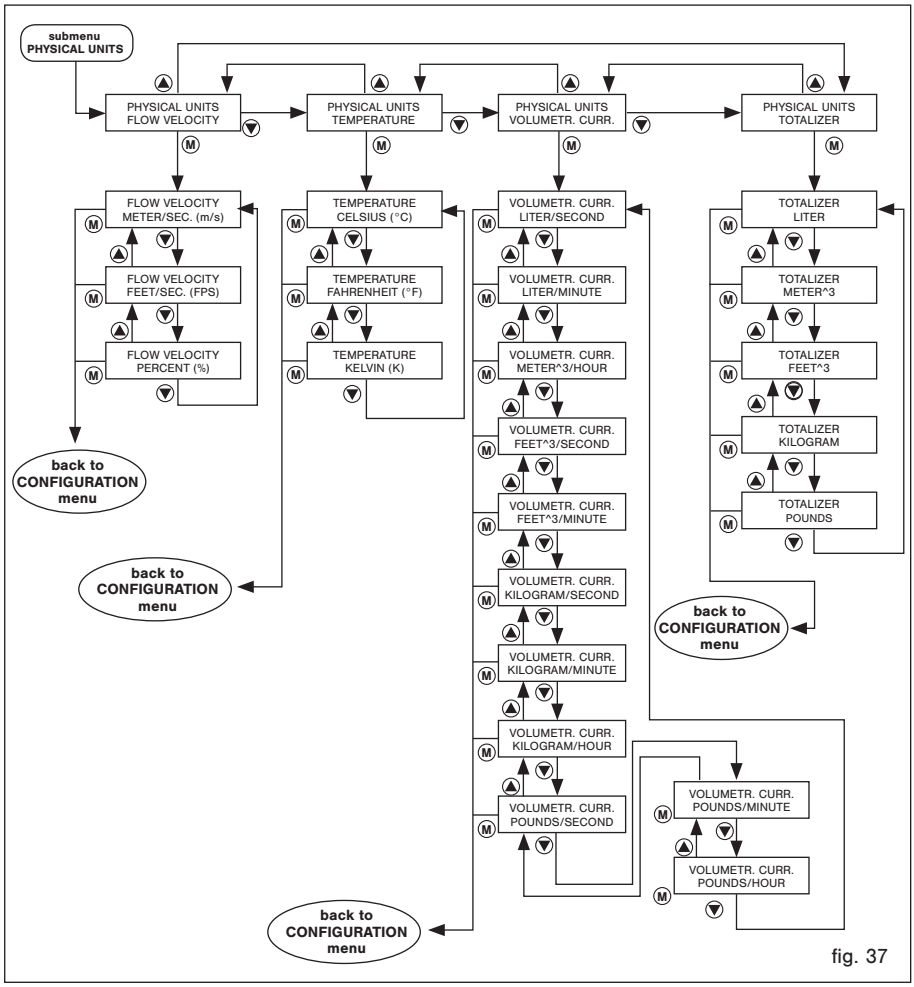



fig. 37

This submenu is used to select the unit of flow velocity, temperature, volumetric current and the totalizer. All quantities will be indicated in the units selected. Figure 37 shows all units which can be selected.

**Note:**
If the totalizer unit is changed, the value already counted will be converted.

## 5.8 Display select

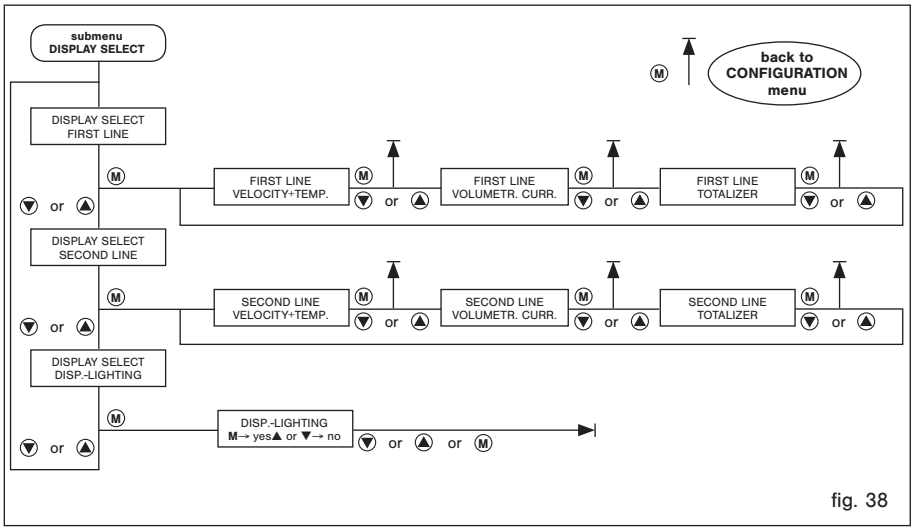



fig. 38

The FC100-CA enables the user to define both lines of the display in certain points. It is possible to select the quantities indicated on both lines (see fig. 38). The unit of the indicated quantities may be selected in submenu PHYSICAL UNITS (see fig. 37).

Submenu DISPLAY-LIGHTING enables the user to choose weather the display is permanently lighted or lighting is deactivated 30 seconds after the last keystroke.

The display-lighting will also be activated if an error occures. It will be deactivated 30 seconds after the error was rectified.

## 5.9 User outputs

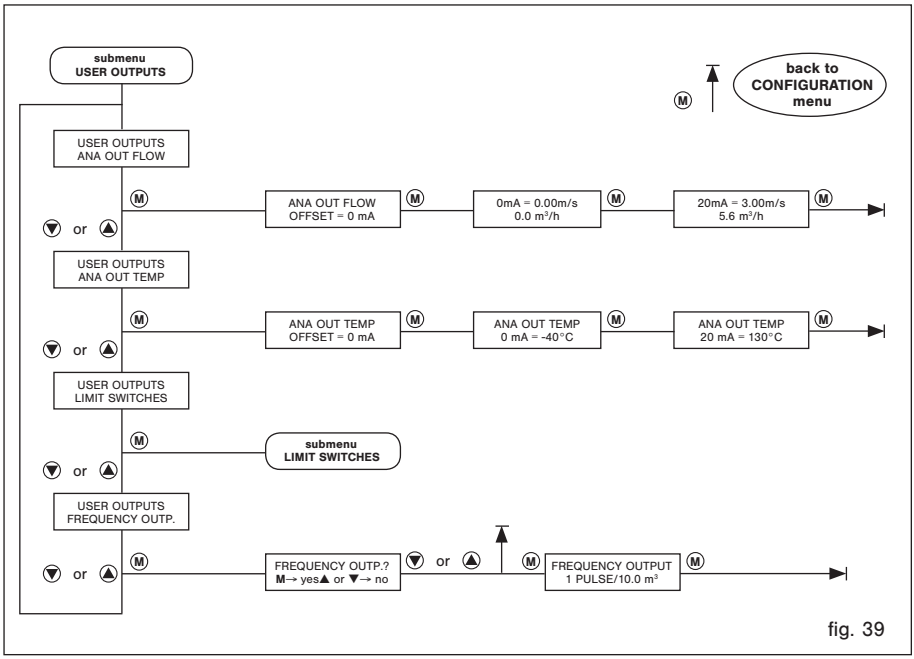



fig. 39

The following USER OUTPUTS may be adjusted in this submenu (see fig. 39):

- analogue output – flow velocity (see chapter 5.9.1)
- analogue output – medium temperature (see chapter 5.9.2)
- limit switches (see chapter 5.10)
- frequency output (see chapter 5.11)

### 5.9.1 Analogue output – flow velocity

This menu option allows adjustment of the flow velocity analogue output specifically to the requirements of the entire system.

Options are:

- OFFSET 0/4 ... 20 mA, 0/1 ... 5 V, 0/2 ... 10 V
- INITIAL VALUE 0/20% corresponds to a flow velocity of ... [m/s] [%] [FPS]
- FINAL VALUE 100% corresponds to a flow velocity of ... [m/s] [%] [FPS]

When entering the initial or final value, the user should observe a reasonable resolution.

With a flow volume/time unit selected in menu PHYSICAL UNITS and when setting the initial and end values, the pertinent flow volumes will also be indicated.

### 5.9.2 Analogue output – medium temperature

In conformance with the configuration “Analogue output – flow velocity” (see chapter 5.9.1) it is possible to adjust the medium temperature analogue output to the requirements of the entire system.

Options are:

- OFFSET 0/4 ... 20 mA, 0/1 ... 5 V, 0/2 ... 10 V
- INITIAL VALUE 0/20% corresponds to a medium temperature of ... [°C] [°F] [K]
- FINAL VALUE 100 % corresponds to a medium temperature of ... [°C] [°F] [K]

When entering the initial or final value, the user should observe a reasonable resolution.

## 5.10 Limit switches

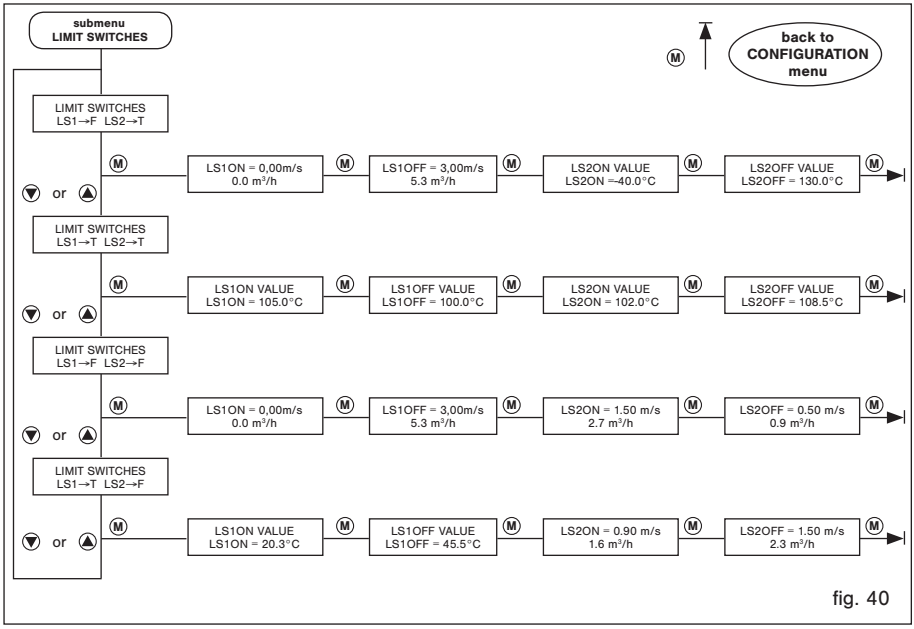



fig. 40

The FC100-CA comprises two limit switches (LS1 and LS2) which are assigned to the physical quantity/quantities to be monitored in submenu LIMIT SWITCHES (see fig. 40).

The following combinations are available:

- LS1 → F and LS2 → T
  limit switch 1 → flow velocity
  limit switch 2 → medium temperature
- LS1 → T and LS2 → T
  limit switch 1 → medium temperature
  limit switch 2 → medium temperature
- LS1 → F and LS2 → F
  limit switch 1 → flow velocity
  limit switch 2 → flow velocity
- LS1 → T and LS2 → F
  limit switch 1 → medium temperature
  limit switch 2 → flow velocity

Mode of operation, limit value and hysteresis of the limit switches are determined by the switch-on and switch-off values of LS1 and LS2 (see chapter 5.10.1).

### 5.10.1 Limit switches – switch-on/switch-off value

Depending on the configuration limit values 1 and 2 may be set either for flow velocity or medium temperature.

The limit value may be set over the entire display range (-40 °C ... 130 °C | 0 m/s ... 99.99 m/s) and is always related to the display value.

Limit switch up-date is by measuring rate, independent of the set measuring time.

The hysteresis is determined by entering different switch-on and switch-off values. Its magnitude should be reasonably adjusted to current operating conditions.

A specific definition of the operation (closed-current or open-circuit principle) may be dropped by separately entering the switch-on and switch-off value of the limit switch, because the definition is deducted from the switch-on and switch-off value.

**Example 1**: Switch-on value lower than switch-off value

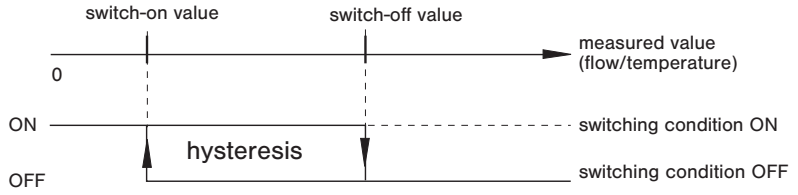



fig. 41

**Example for ON:**

FC100-CA with relay outputs (option R2):

- LIM1 - LIM1COM = closed

  /LIM1 - LIM1COM = open

FC100-CA with transistor outputs (option T4):

- LIM1E - LIM1C = switched

**Example 2**: Switch-on value higher than switch-off value

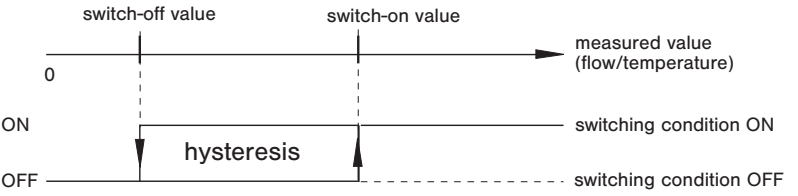



fig. 42

## 5.11 Pulse output for totalizer (frequency output)

The totalizer function of the FC100-CA has been expanded by the output of **proportional quantity pulses**. The function can only be displayed by version **FC100-CA-U1T4 ...** (transistor outputs).

The proportional quantity pulses have been determined as follow:

| **1 pulse/quantity (totalizer unit selected)** |
|---|

Example: 1 pulse/10.0 [litre]
The frequency output will supply 1 pulse per 10 litres (totalized quantity).

When the quantity-proportional pulses are assigned, the frequency of the pulse output must not exceed 10 Hz. The limits that can be displayed are determined by the flow velocity range and the pipe diameter.

Potential setting range of the pulse output: 1 pulse per 0.1 ... 999.9 [liter], [$m^3$] ...

**Behaviour of the pulse output when the max. frequency is exceeded**

The max. frequency being exceeded will not cause the measurement to stop but will rather cause the error output to signal error 60 on the display. This error is included in priority group III.

If a combination of priority III errors occurs simultaneously, they are indicated or stored in the error memory observing the following sequence:

Error No. 20, 30, 60, 40, 41.

**Behaviour of the pulse output when the measurement is stopped**

When the measurement is stopped (as caused by priority II error and calling the CONFIGURATION menu), the pulses for the quantity already counted will be available. Thereafter the output of pulses will be stopped, with the pulse output becoming high resistive until the measurement is restarted.

**Behaviour of the pulse output when the content of the totalizer is deleted**

The content of the totalizer may be deleted by simultaneously pressing ▲ UP and ▼ DOWN = (▲ + ▼) in the main menu.

## 5.12 Measuring time

The measuring time may be between 1 and 30 seconds, referring both to flow rate and medium temperature.

The effect of the measuring time may be compared to that of a low pass filter. It is used to determine the average of the last measured values after each measurement.

The set measuring time does not influence the measuring rate and display update.

## 5.13 Scaling factor (flowscale)

The scaling factor influences flow rate indication.

The factor, which may be set between 0.01 and 9.99, allows flow rate indication changes (increasing or reducing the measured value in the display).

For example, the scaling factor may be used to indicate the average flow rate in the pipeline rather than that available at the sensor.

## 5.13 Quitting the configuration menu

To quit the configuration menu, the controller will check the data entered for plausibility. "CONFIG. OK!" is indicated when the data are correct. The menu may than be quitted by pressing (M) MODE.

Errors found during the plausibility check are indicated in the following sequence of priority.

Priority of entry errors in the CONFIGURATION menu:

| | | |
|---|---|---|
| ERR. A-OUT FLOW<br>OUT OF RANGE | → | analogue output – flow velocity<br>flow analogue output outside measuring range |
| ERR. A-OUT FLOW<br>ZERO ≥ FS | → | analogue output – flow velocity<br>initial value ≥ final value |
| ERR. A-OUT TEMP.<br>OUT OF RANGE | → | analogue output – medium temperature<br>temperature analogue output outside measuring range |
| ERR. A-OUT TEMP.<br>ZERO ≥ FS | → | analogue output – medium temperature<br>initial value ≥ final value |
| ERROR LS1<br>ON = OFF | → | switch-on value for limit switch 1 equals switch-off value for limit switch 1 |
| ERROR LS2<br>ON = OFF | → | switch-on value for limit switch 2 equals switch-off value for limit switch 2 |

The menu can only be quitted after correction of the error(s). To do this, return to the beginning of the configuration menu by pressing (▲) UP or (▼) DOWN and select the menu option with the incorrect entry for correction.

# 6 Errors

## 6.1 Test and diagnosis

The FC100-CA is provided with extensive test and diagnosis functions.
All faults found will be shown in the display with the corresponding error number (e.g. ERROR-No. = 10).
If the FC100-CA is fitted with a T4 option ( 4 transistor outputs), the output ERROR will additionally be activated.

The functions may be classified in three priority groups.

### 6.1.1 Priority group I

Priority group I comprises the switch-on test routines (FC100-CA self-test) which are carried out when the system is switched on.

Their implementation is indicated.

Errors No. 1 to 5 do not allow system operation.

The test routines may be repeated by pressing any key.

If even after several trials the switch-on test cannot be conducted without error indication, the system should be returned to the supplier for rectification, indicating the error number.

Priority I errors cannot be rectified by the user!

### 6.1.2 Priority group II

These test functions are continuously carried out during operation. The occurrence of errors No. 10 and 21 will cause measurements to stop, indicating the error and monitoring the source of the error. Upon rectification of the error, the system will automatically return to measuring operation.

### 6.1.3 Priority group III

These test routines are also continuously carried out during operation.

Other than the above priority groups, errors No. 20, 30, 60, 40 and 41 will not cause measurements to stop; the error output will indicate and the number of the error will be shown on the display.

## 6.2 Potential errors

Independent of the priority group, all errors found are indicated with their relevant number.

In order to facilitate operation, the last error is stored in a non-volatile memory. The stored error may be retrieved and deleted in the main menu.

If a combination of errors occurs simultaneously, they are indicated or stored in the error memory observing the following sequence.

**Priority group I**

| Error | Cause | Rectification |
|---|---|---|
| No. 1 | No system parameter available | Return to supplier. |
| No. 2 | Incorrect checksum of parameter memory | Return to supplier. |
| No. 3 | Incorrect checksum of program memory | Return to supplier. |
| No. 4 | Incorrect checksum of data memory | Return to supplier. |
| No. 5 | Internal controller error | Return to supplier. |

**Priority group II**

| Error | Cause | Rectification |
|---|---|---|
| No. 10 | Sensor not connected; cable between FC100-CA and sensor or sensor defective | Check cable or replace sensor. |
| | Sensor selected (CONFIGURATION menu) differs from sensor connected | Correct sensor selection in CONFIGURATION menu |
| No. 21 | Medium temperature too high | |

**Priority group III**

| Error | Cause | Rectification |
|---|---|---|
| No. 20 | Medium temperature too low | |
| No. 30 | Over limits of flow rate | |
| No. 60 | Assignment of quantity per pulse too low * | |
| No. 40 | Controller error (oscillator-watchdog) | |
| | Admissible EMC levels may have been exceeded | |
| No. 41 | Controller error (watchdog-timer) | |
| | Admissible EMC levels may have been exceeded | |

* Error No. 60 can only occur with version FC100-CA-U1T4 ...

# 7 Technical data

## 7.1 Ambient conditions

| | rail-mounted version | surface mounted version |
|---|---|---|
| Storage temperature: | -20 ... 70 °C | -20 ... 70 °C |
| Ambient temperature: | 5 ... 50 °C | 5 ... 50 °C |
| Degree of protection: | IP20 | IP65 |

## 7.2 Electrical characteristics

**DC supply**

| Connector pin assignment: | signal name | Pin XV |
|---|---|---|
| | shield | 1 |
| | $+U_V$ | 2 |
| | $-U_V$ | 3 |

**Caution!**

**Pin XV1 (Shield) is internally connected to pin XV3 ($-U_V$).**
**The housing is connected to shield potential.**

Input voltage range: $U_V$ = DC 10 ... 40V (ripple incl.)

Admissible ripple: max. 20% $U_V$

Max. current consumption:
I = 650mA at $U_V$ = 10V
I = 500mA at $U_V$ = 12V
I = 240mA at Uv = 24V
I = 150mA at $U_V$ = 40V

## 7.3 Analogue outputs

**The analogue outputs are galvanically isolated from the electronic control unit FC100-CA.**
**Connector pin assignment for analogue outputs V1, V2 and C1:**

| Signal name | Pin XAO |
|---|---|
| NC | 1 |
| analogue output 1 - flow | 2 |
| reference ground 1 | 3 |
| shield 1 * | 4 |
| shield 2 * | 5 |
| analogue output 2 - temperature | 6 |
| reference ground 2 | 7 |
| NC | 8 |
| NC - not used | |

Analogue output 1 - ANA OUT FLOW (flow output)
Analogue output 2 - ANA OUT TEMP (temperature output)

*** Shield ungrounded - apply on one side only**

The output is reverse polarity protected.
Insulation voltage: analogue output - central electronic unit DC 500 V

### 7.3.1 Voltage output V1 - 5 V FS

| | |
|---|---|
| Signal voltage range: | $U_S$ = 0 V (1 V) to 5 V |
| Accuracy: | ± 0,75 % FS |
| Resolution: | 10 Bit (5 mV) |
| Min. admissible load resistance: | $R_l$ = 1 kΩ |
| Max. admissible load capacity: | $C_l$ = 1 nF |
| Max. admissible load inductance: | $L_l$ = 100 nH |
| Short circuit proof: | yes (XAO - between all terminals) |

### 7.3.2 Voltage output V2 - 10 V FS

| | |
|---|---|
| Signal voltage range: | $U_S$ = 0 V (2 V) to 10 V |
| Accuracy: | ± 0,75 % FS |
| Resolution: | 10 Bit (10 mV) |
| Min. admissible load resistance: | $R_l$ = 2 kΩ |
| Max. admissible load capacity: | $C_l$ = 1 nF |
| Max. admissible load inductance: | $L_l$ = 100 nH |
| Short circuit proof: | yes (XAO - between all terminals) |

### 7.3.3 Current output C1 - 20 mA FS

| | |
|---|---|
| Signal current range: | $I_S$ = 0 mA (4 mA) to 20 mA |
| Accuracy: | ± 0,75 % FS |
| Resolution: | 10 Bit (20 µA) |
| Min. admissible load resistance: | $R_l$ = 0 Ω |
| Max. admissible load resistance: | $R_l$ = 300 Ω |

## 7.4 Signal outputs

**The signal outputs are galvanically isolated from each other as well as from the electronic control unit FC100-CA.**

### 7.4.1 Relay outputs R2 (DC or AC)

| Connector pin assignment: | Signal name | Pin XAH |
|---|---|---|
| | Limit Switch 1 / shield | 1 |
| | Limit Switch 1 / N.O. | 2 |
| | Limit Switch 1 / common | 3 |
| | Limit Switch 1 / N.C. | 4 |
| | Limit Switch 2 / shield | 5 |
| | Limit Switch 2 / N.O. | 6 |
| | Limit Switch 2 / common | 7 |
| | Limit Switch 2 / N.C. | 8 |

**Resistive load**

| | |
|---|---|
| Max. admissible switching capacity: | 50 W |
| Max. admissible switching current: | 1 A |
| Max. admissible continuous current: | 1 A |
| Max. admissible switching voltage: | 50 V |
| Contact life at 1 A: | $3 \times 10^5$ cycles |

**Inductive load - with safety circuit - AC voltage**

| | |
|---|---|
| Max. admissible switching capacity: | 125 VA |
| Max. admissible switching current: | 1.25 A |
| Max. admissible continuous current: | 1.25 A |
| Max. admissible switching voltage: | 100 V |
| Contact life cos $\varphi$ = 0.5: | $2.4 \times 10^5$ cycles |
| Insulation voltage: | signal contact - central electronic unit DC 500 V |
| | signal contact - signal contact DC 500 V |

### 7.4.2 **Transistor outputs** (DC)

| Pin selection: | Signal name | Pin XAH | Polarity |
|---|---|---|---|
| | / ERROR emitter | 1 | - |
| | / ERROR collector | 2 | + |
| | / BUSY / PULSE emitter | 3 | - |
| | / BUSY / PULSE collector | 4 | + |
| | Limit Switch 2 emitter | 5 | - |
| | Limit Switch 2 collector | 6 | + |
| | Limit Switch 1 emitter | 7 | - |
| | Limit Switch 1 collector | 8 | + |

**Voltage level**

| | |
|---|---|
| Low level - active: | $U_{ce}$ < 0.8 V at $I_C$ < 10 mA |
| | $U_{ce}$ < 1 V at $I_C$ < 100 mA |
| High level - passive: | $U_{ce}$ < 48 V |
| | $U_{ce\ max}$ = 60 V |
| | max. leakage current ≤ 25 µA |
| Reverse polarity protection: | yes |
| Short circuit protection: | yes |

**Resistive load**

| | |
|---|---|
| Max. admissible switching capacity: | 1.5 W |
| Max. admissible switching current: | 150 mA |
| Max. admissible switching voltage: | 36 V |

**Inductive load - L < 100 mH**
(DC voltage - without external safety circuit)

| | |
|---|---|
| Max. admissible switching capacity: | 1.5 VA |
| Max. admissible switching current: | 40 mA |
| Max. admissible switching voltage: | 36 V |

**Capacitive load - C < 20 µF**

| | |
|---|---|
| Max. admissible switching capacity: | 1.5 VA |
| Max. admissible switching current: | 1.5 A |
| Max. admissible switching voltage: | 36 V |
| Insulation voltage: | signal contact - central electronic unit DC 500 V |
| | signal contact - signal contact DC 500 V |

## 7.5 Metrological data

### 7.5.1 Flow rate measurement

Measuring is possible up to the flow rates indicated in the display range. However, the indicated accuracy is no longer guaranteed.

**The repeatability value remains valid.**

Medium: air

#### 7.5.1.1 Monitoring head CSP with sensor adapter type TP-...

Flow measurement ranges:

| Sensor adapter type | Measuring range in $Nm^3/h$ | Display range in $Nm^3/h$ |
|---|---|---|
| TP01 | 0 ... 50 | 70 |
| TP02 | 0 ... 77 | 109 |
| TP03 | 0 ... 120 | 170 |
| TP04 | 0 ... 197 | 280 |
| TP05 | 0 ... 308 | 439 |
| TP06 | 0 ... 480 | 685 |

| | |
|---|---|
| Response delay: | 3 s |
| Accuracy [1] : | ± 3% MW ** / ±0.1 % MBE * |
| Repeatability: (5 % MBE to 100 % MBE) | ± 1% MW / ±0.5 % MBE |
| Temperature drift: | ± 0.05 %/K/MBE |

* MBE - of final value

** MW - measured value

[1] Please enquire for higher accuracy.

#### 7.5.1.2 Monitoring heads CST and CSF-...

Flow measurement ranges:

The flow measurement range is determined by the inside pipe diameter (see table).

It can be calculated with the following equation:

$$\mathbf{Q = V_N \times A_R}$$

Q [$Nm^3/h$] - flow quantity

$V_N$ [m/h] - average standard velocity

$A_R$ [$m^2$] - inside pipe cross-section

| Inside pipe diameter D in mm | Measuring range in $Nm^3/h$ | Display range in $Nm^3/h$ |
|---|---|---|
| 20 | 76 | 113 |
| 30 | 173 | 254 |
| 40 | 307 | 452 |
| 50 | 480 | 706 |
| 60 | 692 | 1017 |
| 70 | 942 | 1385 |
| 80 | 1230 | 1809 |
| 90 | 1557 | 2290 |
| 100 | 1922 | 2827 |
| 150 | 4325 | 6361 |
| 200 | 7690 | 11309 |
| 250 | 12016 | 17671 |
| 300 | 17303 | 25446 |
| 400 | 30762 | 45238 |
| 500 | 48066 | 70685 |
| 600 | 69215 | 101787 |
| 700 | 94210 | 138544 |
| 800 | 123049 | 180955 |
| 900 | 155734 | 229021 |
| 1000 | 192265 | 282743 |

| | |
|---|---|
| Setting range for inside pipe diameter: | 10.0 mm ... 999.9 mm |
| Velocity range: | 0 ... 68 Nm/s (100 Nm/s) |
| Accuracy[1)] : | ± 5 % MW ** / ±0.5 % MBE * |
| Repeatability (5% MBE to 100% MBE): | ± 1 % MW / ±0.5 % MBE |
| Temperature drift: | ± 0.05 %/K/MBE |

### 7.5.2 Temperature measurement

| | |
|---|---|
| Measuring range: | - 40 ... +130 °C / -40 ... +266 °F |
| Accuracy: | ±1 % MB *** |

### 7.5.3 Electronic control unit FC100-CA

| | |
|---|---|
| Temperature drift: | 0.1 %/K/MBE * (CSP-...) |
| | 0.05 %/K/MBE * (CSF-..., CST-...) |
| Warm up period until full accuracy is reached: | 5 minutes |

* MBE – of final value, ** MW – measured value, *** MB – measuring range
1) Please enquire for higher accuracy.

## 7.6 Sensor interface

**Electrical data of the terminal for calorimetric monitoring heads**

| Terminal | Mnemonics | Data |
|---|---|---|
| XSK1 | R(HEIZ)-LO | Function: terminal for negative pole of heater element<br>Drain output of heating current control<br>Max. sink current: $I_{sink}$ = 88 mA<br>Electric strength: -0.5 V ... +20 V DC |
| XSK2 | R(HEIZ)-HI | Function: terminal for positive pole of heater element; hi-potential of heater source; output voltage range (load dependent)<br>$U_a$ = 21 V ... 24 V DC<br>Max. current output: $I_{max}$ = 100 mA<br>Not short-circuit proof |
| XSK3 | R(Tref)-HI | Function: terminal for positive RTD * pole for medium temperature measurement<br>Input resistance: > 1 GΩ<br>Electric strength: -17 V ... +30 V DC |
| XSK4 | R(Tref)-LO | Function: terminal for negative RTD * pole for medium temperature measurement<br>Input resistance: > 1 GΩ<br>Electric strength: -17 V ... +30 V DC |
| XSK5 | AGND | Function: analogue ground<br>Reference potential of current source for RTD * operation |
| XSK6 | IS | Function: output of current source for RTD * operation<br>Output current: 1 mA ± 1 %<br>Admissible load range: $R_{load}$ = 0 ... 2 kΩ<br>Electric strength: ±15 V DC |
| XSK7<br>XSK8 | SGND | Function: shield ground<br>Terminals for sensor cable shielding |
| XSK9 | R(Tdiff)-LO | Function: terminal for negative pole of the heated RTD *<br>Input resistance: > 1 GΩ<br>Electric strength: -17 V ... +30 V DC |
| XSK10 | R(Tdiff)-HI | Function: terminal for positive pole of the heated RTD *<br>Input resistance: > 1 GΩ<br>Electric strength: -17 V ... +30 V DC |

* RTD = **R**esistive **T**emperature **D**evice

# 8 Accessories

| No. | Accessory | Order reference |
|---|---|---|
| 1 | Surface mounted housing | FC100-CA-FH |
| 2 | Connecting cable for calorimetric monitoring head | |
| | cable type LifYCY 4 x 2 x 0.2 mm$^2$<br>- type 15 / -10 ... +80 °C / +14 ... +176 °F highly flexible/paired<br>- type 18 / -60 °C ... +200 °C / -76 ... +392 °F halogen-free/highly flexible/paired | Do+Ka |
| 3 | Calorimetric monitoring heads | CST/CSP/CSF |
| 4 | Sensor adapter (screw-in or welding type) | TP |
| 5 | Ball valve | BV |
| 6 | Locking set 01 (for monitoring head CSF-...) | 0Z122Z000204 |

## Appendix 1 - Performance of the digital and analogue outputs during the operating and error modes

| Duty/ Error status | LIMIT SWITCH 1 | LIMIT SWITCH 2 | NO ERROR | NOT BUSY/ FREQUENCY OUTPUT | ANA OUT FLOW | ANA OUT TEMP |
|---|---|---|---|---|---|---|
| Start-up (Reset) | ON | ON | ON | ON | MAX | MAX |
| Start-up test active | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 1 | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 2 | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 3 | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 4 | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 5 | OFF | OFF | OFF | OFF | MIN | MIN |
| Heating period active | OFF | OFF | ON | OFF | MIN | MIN |
| **Normal operation** | **X** | **X** | **ON** | **ON** | **X** | **X** |
| Configuration active | OFF | OFF | ON | OFF | FREEZE | FREEZE |
| Error No. 10 | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 20 | X | X | OFF | ON | X | X |
| Error No. 21 | OFF | OFF | OFF | OFF | MIN | MIN |
| Error No. 30 | X | X | OFF | ON | X | X |
| Error No. 60* | X | X | OFF | FA | X | X |
| Error No. 40 | X | X | Y | ON | X | X |
| Error No. 41 | X | X | Y | ON | X | X |

X = standard performance

Y = OFF pulse

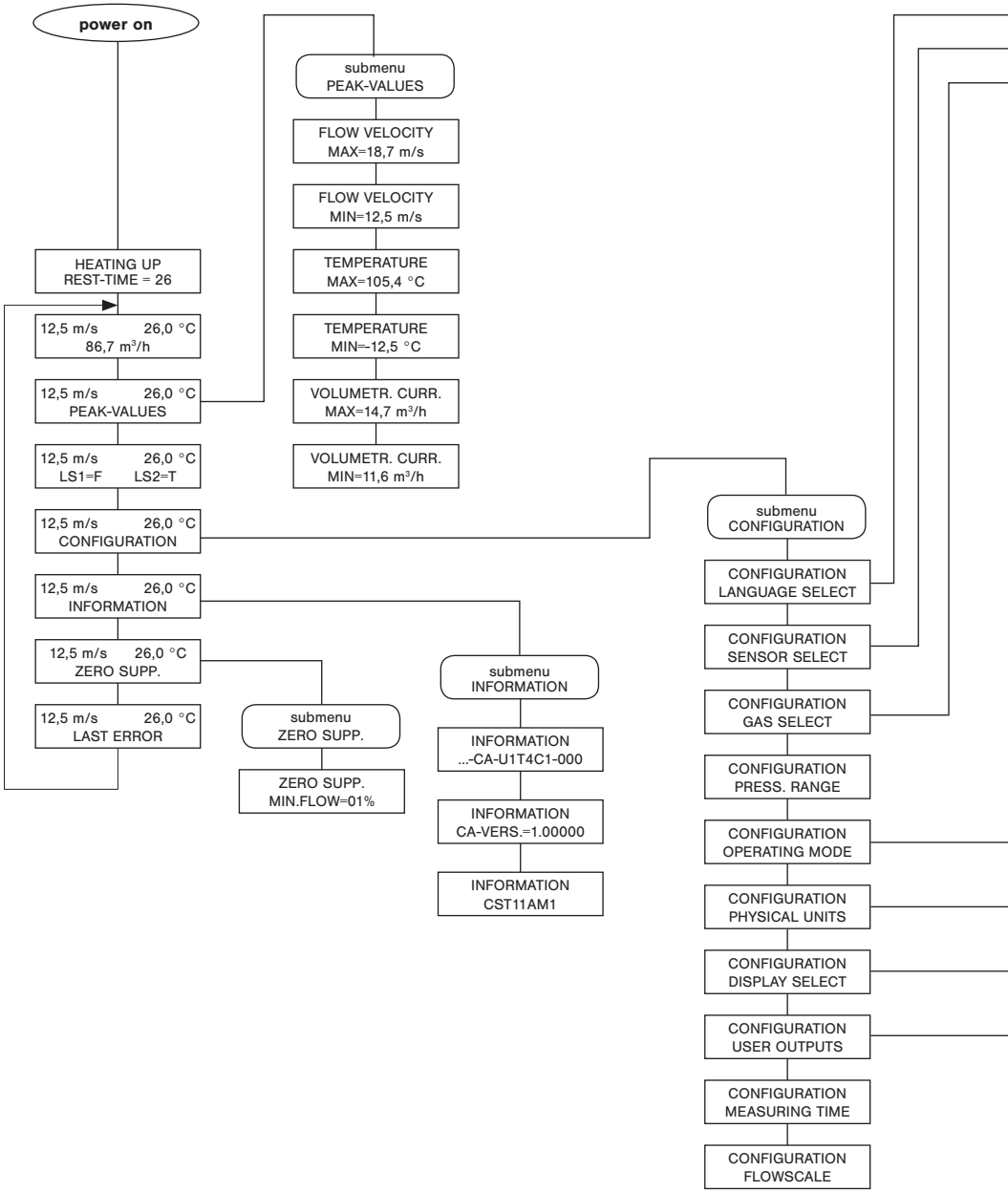
FA = frequency output 10 Hz

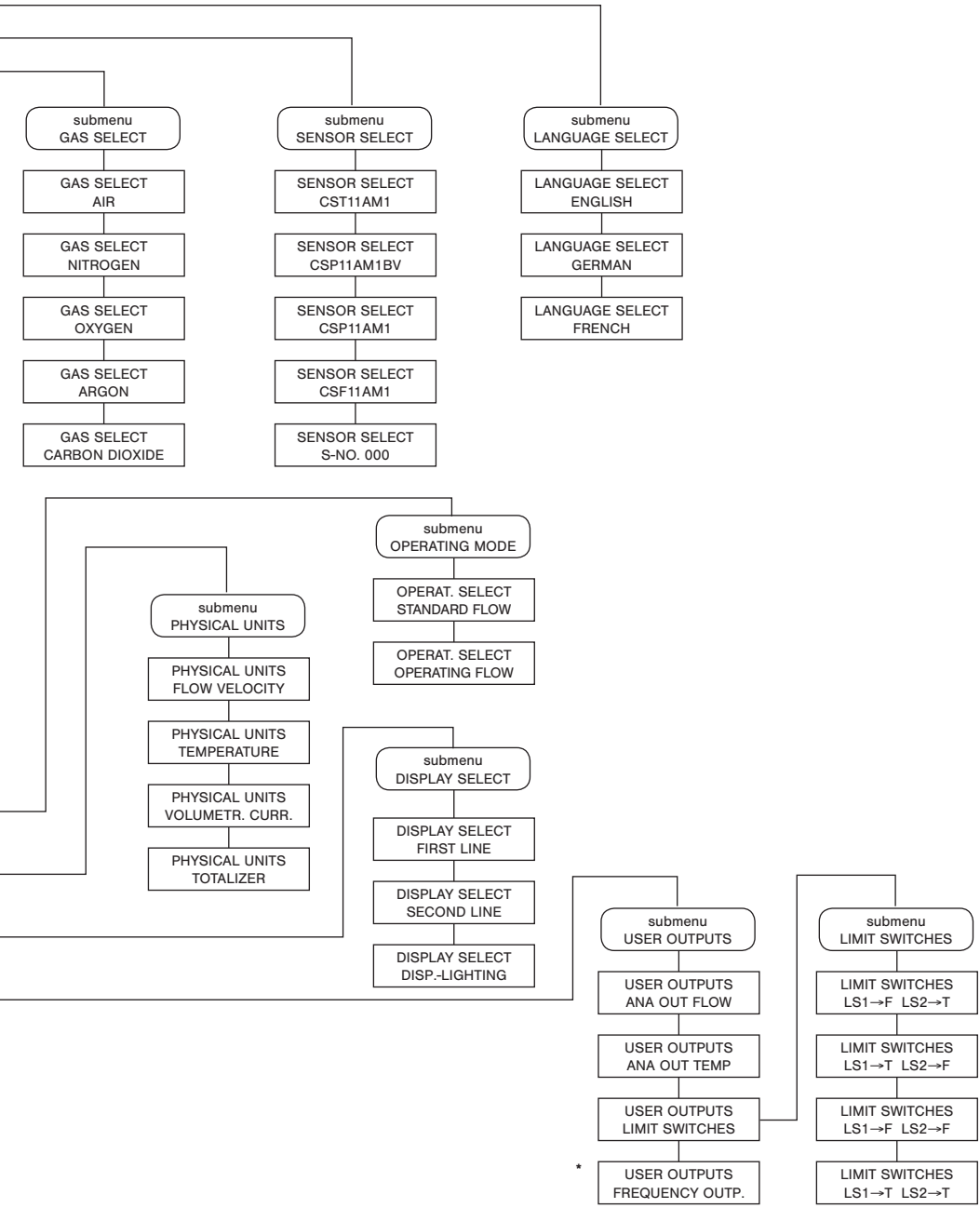
FREEZE = the last output value before error occurred will be retained

* When frequency output has been selected.

Note: The occurence of error No. 40/41 will always cause an internal reset
Status of the outputs prior to the error status described
→ see start-up (reset)

## Appendix 2 - Menu structure of the FC100-CA






* Only FC100-CA-U1T4 ...

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